INTERVIEWS

WITH

MINING ENGINEERS

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PREFACE

This book is a reprint of my interviews with leaders of the mining profession, together with editorial appreciations written by me in the 'Mining and Scientific Press', in which the interviews were published. The last interview, of which I am the subject, appeared in the 'Engineering and Mining Journal-Press', together with the 'Apologia'. The publication of this series of interviews and biographic articles has been prompted by numerous suggestions to the effect that they deserved to be collected in more convenient and more permanent form. They ought to help the younger men, and they will, I hope, interest the older ones. Since they were started three of the subjects have crossed the range: Hennen Jennings, Anthony F. Lucas, and Philip Argall. I am glad to have been able to say something kind and true about them before they went beyond. The interviews are better than obituaries in recording their achievements and in perpetuating their reputations. No changes have been made in the text, so there are a few repetitions. These do not matter. It seemed to me best to make no change, for the interviews are genuine; they are the stenographic record of what was said in these orderly conversations. I have sacrificed literary excellence to genuineness, which I hold to be the more valuable.

T. A. RICKARD.

San Francisco, California, May 1, 1922.

PHILIP ARGALL

AN INTERVIEW

Mr. Argall, your name suggests that you are of Cornish origin.

My father was Cornish, my mother Scotch-Irish. I was born in Newtownards, county Down, Ireland, in 1854 and was 25 years old before leaving the country. I used to call myself an Irishman until I became an American by naturalization, in 1889.

Was your father engaged in mining?

My father, Philip Argall, descended from a Cornish mining family, spent his lifetime in the mining business, commencing with tin, lead, and copper mining in Cornwall, leading to lead and coal mining in Wales, and I believe, lead mining in the Isle of Man. At the time of my birth my father was at the Conlig mine, near Bangor, this mine being at that time the greatest lead-producer in Ireland and possibly in the British Isles; the family moved to the Wicklow copper mining district in 1858, and a year later my earliest recollection of mining begins. My father left Ovoca in 1872 to engage in coal mining in county Tyrone; he died in Dungannon in 1887, in his 72nd year.

Have you any personal recollection of the Conlig mine?

I visited the locality in 1911 and saw the ruined tower of the famous wind-mill that operated the crushing machinery in the early 'fifties. The large dumps of jig-tailing adjoining bore ample testimony to the power developed by this huge wind-mill, of which I heard my father speak so often. In average weather it ran the whole dressing-works, but as a local wit remarked, "she had her off days, and in that respect was more human than the steam pumping-engine that was never affected by the weather".

The architecture indicates the work of Cornishmen?

Yes, the engine-house is typically Cornish; indeed, every-

thing except the wind-mill would pass as an old-time Cornish mining scene. The general manager was Silas Evans, one of the foremost lead miners of his day; he too worked his way up from Cornwall through Wales to the Isle of Man lead mines and thence to Conlig.

I suppose the mine was abandoned after the ore was exhausted?

Yes, my father often said he considered the mine bottomed except at the bog shaft, and there the ore occurred in barite gangue, and they failed in raising the lead to marketable grade. I saw much barite in the dumps in 1911; also some evidence that recent attempts had been made at re-working them, evidently with unsatisfactory results.

What is your earliest recollection of mining?

Strange to say, it is closely connected with this great State of California. It was an attempt at gold mining on the Aughrim river, a tributary of the Ovoca river, county Wicklow. I remember a Californian miner in a red-flannel shirt; he was boss of the New Diggings. It was the first red shirt I ever saw. In the land of the 'sleeved waistcoat' he wore no vest; his hat had the widest brim it had been my privilege to gaze upon. For a year he was the hero of my childhood, and to this day nothing in my early life stands out so clear-cut and so vivid as that Californian gold miner in 1859, with his red shirt, sleeves rolled up, hat tilted back. I see him yet, prominently posed on the bank shouting orders to the workmen below.

So you can recollect gold mining in Ireland; what became of this venture?

I remember the sluicing operation distinctly and also that in rummaging in the sluice after work was over I found something yellow one day, about the size of a wheat grain. They told me it was a gold nugget, the first found at that place. I date my mining career from that event. The placer mining did not prove profitable, and not finding veins, they collected the float-quartz from the hillsides and treated it in a stamp-mill erected to crush it. The stems were of oak and the hard quartz got the best of the cast-iron heads.

The next move consisted in roasting the quartz in a sort of

lime-kiln, and quenching it with water, before stamping. The roasted quartz went through the battery without incident, that I can recall; then came the clean-up, and, as I learned afterward, no amalgam, so the mercury was finally volatilized in an iron ladle over the forge-fire and "like the baseless fabric of a vision left not a wrack behind". That process I saw, and realized some of the disappointment. The Irish quartz-rock proved too much for my red-shirt hero, who went out of my life, as it were, in mercurial vapor.

Do you know of any further gold mining in Wicklow?

Nothing of importance. In 1875 I assisted G. Henry Kinahan of H. M. Geological Survey, in looking over the placer workings; some three or four men were at that time eking out a scant existence with pick and pan. I re-visited the place in 1901 and heard that one old gold-miner was still active in the district.

What was the source of the gold?

Mr. Kinahan believed the gold came from the oxidation and disintegration of the pyritic lodes, and my subsequent experience in other countries inclines me to support that view.

Do the Wicklow copper lodes contain gold?

Yes, in minute quantity; it was only in the gossan that visible gold occurred, or immediately below it, in what is now called the zone of secondary enrichment; assays of several ounces of gold per ton have been obtained in that zone.

Did you have any regular mining education?

Not of the college type; before reaching my 16th year I finished the grammar-school work, and obtained a grounding in Latin, and such familiarity with Macaulay, Shakespeare, and the English Bible as has stood by me ever since. Shakepeare I disliked until I reached the years of maturity, but he has long since been my favorite author.

I spoke of mining education.

I am coming to that; when 16 I was laboring 10 hours per day in the dressing-works of the Tigroney mine and receiving a penny per hour as compensation. I soon learned about all

that was then known regarding jigs, buddles, and copper-ore dressing, as well as the method then used in precipitating copper from mine-waters. I also studied three evenings per week with a tutor. At 17 I worked 8 hours per day in the mine and took two hours instruction daily from Capt. Chamley, an ex-officer of the Ordnance Department of the British army, on mathematics and surveying. We had at that time a sort of mining college on Stephens Green, in Dublin. I believe it was called the Royal College of Science for Ireland. The Wicklow mines were but 40 miles from Dublin and we saw much of the professors; they were very kind to me, giving me books to study and directing my reading in chemistry. I particularly recall Prof. J. P. O'Reilly, Prof. Robert Galloway, also, whose 'Qualitative Analysis' was my chemical 'horn book.' I owe much to these men and perhaps most to a scientist whose name I cannot now recall. I had shown this gentleman through the mines, and we were lunching together, when he asked me about the blow-pipe. I knew nothing about it. His conversation greatly impressed me; he went out and scraped some of the mud off the road, explaining that the minute pieces of hoof and hair in the mud should react for ammonia in the closed tube. To my astonishment it did. He fixed me up with a blow-pipe and a list of books. These I procured, and set to work. He insisted on checking over my notes and within six months I was quite handy with the blow-pipe. To this scientist I am also indebted for notes, how to record the essential information in brief form, arranged for ready reference. I only regret he did not impress on me the importance of dates. In 25 years past I have on every available occasion told my assistants and younger friends that the date is often as valuable as the other data, sometimes more so, and should always form the first notation on every sheet.

How did you study experimental chemistry?

I purchased some few pieces of apparatus and some reagents to putter along with, but at 20 I was fortunate in being able to pick up a complete laboratory apparatus, reagents and all, at a defunct mine. The equipment came from Germany at the time elaborate experiments were made by German metallurgists on the Connary ores.

In connection with the leaching of copper, I suppose?

Yes, kernel-roasting and copper-leaching. I visited the plant almost every day on my way home from school; the laboratory always commanded my admiration, and years afterward when I obtained possession of it I was a proud boy indeed, though I had borrowed more than half the money I paid for it. Some 30 years later I met the late George W. Maynard in New Mexico, and on comparing notes found he was in charge of the Connary mine when kernel-roasting was tried in 1866-8. We then exchanged much information of mutual interest and remained fast friends thereafter. I made good use of this laboratory and soon got out of debt by making sulphur and copper determinations; previously the former had been sent to Dublin and the latter to Swansea or Cornwall for assay. In the year 1879 I took a course in metallurgy at Swansea, Wales, then the metallurgical centre of the world as regards copper. Such was my mining education, or rather the basis of it. I grew up among mines and metallurgical works, absorbing practical details as I grew, and learning the scientific details later.

You remained a student always?

Yes, throughout my active life. Modern mining and metallurgy keeps one—if he expects to remain in the procession—a continuous student, however humble his part.

You were subsequently connected with the Wicklow copper mines, were you not?

Yes, I worked at all kinds of mining, driving, raising, sinking, stoping in both hard and timber ground. In 1873 I was promoted to shift-boss in the Cronebane mine, and two years later was assistant-manager with title of Captain, as Cornish customs prevailed there.

You have written about copper precipitation underground at that property?

The Cronebane mine did not command the mouth of the main adit. I knew from repeated analyses of the waters that our mine was furnishing its principal copper content. When the manager was fully convinced that the copper came from our property and that it could be precipitated from the mine-waters

underground, a demand was made on the Tigroney company for a share of the profit and was turned down hard. My people still had an obsession that precipitation in the mine might lead to some complication, so I was first instructed to place 100 ft. only of launders; these were filled with tin-plate scrap, the precipitation was simply wonderful, the precipitate assaying nearly 90% copper. The result I soon learned was due to the clear warm water that was collected near its source in the mine, as compared with the cold muddy water, often laden with ochre, that fed the surface precipitation plant. Well, the full plant was then ordered in and in a few months was operating satisfactorily.

So copper precipitation in the mine was an unqualified success?

Not completely so, we had two setbacks that I recall.

What were they?

We had to use all the available space in the mine for precipitation. One unventilated cross-cut 600 ft. long caused the first trouble; following a triple holiday, an explosion took place, burning two men rather painfully. An explosion in a metal mine so alarmed the Chief Mining Inspector that he wired us to leave everything as it was, pending his inspection. We did. I, however, started an investigation on my own account. I had often noticed gas bubbles rise through the clear water, in the launders, so I collected and tested this gas, which proved to be hydrogen. That night I crawled without a light into the cross-cut to where a hole went up in the roof and there collected a wash-bottle full of the air. On reaching my laboratory I began and ended my investigation by holding a light to the mouth of the flask; I had a real first-class explosive mixture in it.

When the Chief Inspector arrived he was placed in my charge; I told him it was hydrogen gas that caused the explosion, showed him the gas bubbles, collected some, and tested them for him. We then entered the cross-cut with Clanny lamps provided by the Inspector, Mr. Dickenson of Pendelton, Manchester, who gave me my first instructions in the use of safety-lamps, and formulated rules for the daily inspection of the 600 ft. of cross-cut before the men were allowed to enter. Mr. Dickenson was greatly impressed with my work on the cause of this explosion and the remedy applied. He gave me prominent mention in his dispatches and annual report, and later

when I left for Cornwall he wrote the Inspector for that district, R. J. Frecheville, to look me up.

What was the other incident you referred to?

At one point on the upper adit a Cornish horse-whim, with two buckets, was utilized to lower the cast-iron used in precipitating. I saw that if a brake was appplied the horses might be eliminated. I got out a design for a brake on the top of the vertical whim 22 ft. from the ground, with rods and levers to the shaft-collar. The manager finally approved the design, but discarded the lugs I had provided to keep the brake-band from rising. The brake worked nicely on the evening it was finished. The next morning we had snow and ice, and in lowering the first bucket of iron, a lump of ice caused the brake-band to lift and slip off the friction-blocks, with the result that the bucket and 1200 ft. of steel-wire rope, the second I ever saw, went down the shaft. I believe it took a week to clean up the wreck. Afterward this apparatus gave great satisfaction.

You wrote some papers on the Ovoca mines?

Yes, two, one describing the geology and ore deposits, the second in collaboration with G. A. Kinahan, on copper precipitation. Both were published by the Royal Dublin Society. The plan and section in the former paper were awarded the first prize for the best plan and section of any mining district at the Royal Cornwall Polytechnic Society's exhibition in 1878.

I remember an article of yours describing the precipitation of copper from the water of the Ovoca mines and the introduction of the mono-rail underground.

I wrote one paper describing the mono-rail, in connection with the precipitation of copper, in a drift where two lines of launders were established; car-tracks could not be used, so the mono-rail was devised for transporting the heavy cast-iron and the copper precipitate, and proved a great success. It is described in the 'Mining and Scientific Press' of July 28, 1906.

A revival of the copper industry in Wicklow was attempted in later years?

Yes, but nothing came of it. Some friends induced capi-

talists to re-open the zone under the gossan explored in 1875-8. I had the records of hundreds of assays I made during that period, as well as my original surveys. Several pits were sunk at places I selected under promise of 3% copper; the ore found, however, averaged nearly 4% copper, about one quarter of which was soluble. Instead of mining the ore in mass (it was about 40 ft. wide) and treating it by some modern process, the new operators followed the practice of the previous centuries, in attempting to dig out the fine seams and stringers of high-grade in the shale and sending the ore to Swansea for reduction. On that basis the enterprise proved unprofitable. A steam-shovel proposition was tackled with pick and timber, and the result was inevitable.

How long were you at these copper mines?

I came there as a child and left in my 25th year to take charge of the Stannic works at Swansea, South Wales.

What kind of business was that?

The principal business was removing the tin from tin-plate scrap; tin and copper matte-smelting was also carried on to some extent; puddling-furnaces and a steam-hammer formed another part of the plant. The Parnell process used then contemplated the removal of the tin from the scrap in a hot solution of sodium sulphide, evaporating the spent liquor, roasting to produce tin oxide and sodium sulphate, smelting the tin oxide, in Cornish furnaces. The iron scrap was heated in the puddling-furnaces and beaten out into blooms under the steam-hammer. In a word, Mr. Parnell intended to sell block tin and tin-plate blooms to the tin-plate works across the valley, so that both the tin and the iron might enter the channel of trade a second time in the form of tin-plate.

Did he succeed in this?

No, both the tin and the iron proved to be 'cold short'; the former could only be sold for some £15 per ton below standard tin, and the iron was unsaleable except for de-sulphurizing in lead-smelting. At the time I took charge of the works no one had ascertained what was the exact trouble with the tin, though considerable money had been spent in complete analyses of the

refined tin; the iron had up to that time been forced into a mold under the steam-hammer, and the compact balls sold to the lead-smelters. On entering the refinery one day our Cornish refiner was struggling with what looked like a very tough slag: I said, "What is that you are trying to pull out of the furnace?" He said: "I don't know; I have been 30 years smelting tin and I never saw no such stuff before"; he continued, "if I was one of them there chemists I'd assay this devilish stuff and not fool with the block tin". I took the hint, secured good samples, chilled them, and set to work, and soon found that the metallic substance was mostly tin sulphide reduced from the sulphate left in our tin oxide. I then determined the sulphate present in the batch of oxide we had ready for smelting, added lime to correct it, and smelted, I believe, a dozen samples, testing each button and finding every one best-grade tin. But I wanted John Uren's opinion; I had worked through the night and our refiner was late in arriving. I placed all the buttons in a ladle and poured several test-bars on the marble slab; when John arrived he nicked and tested each bar and said "It's best Banka, where did you get him?" I replied, "It is our tin scientifically smelted".

I had obtained this, my first independent job, on four months trial; the time was about up, so I repaired, after breakfast, to the head office and emerged from a directors' meeting an hour later with a year's contract in my hand and 50% advance in wages, provided I kept the tin up to the grade of Banka in the future. With the assistance of John Uren, the Cornish refiner, this happy result was maintained, and John, too, who gave me the 'stuff' to work on, was duly rewarded.

What quantity of sulphur will render tin 'cold short'?

About 0.02% sulphur will render tin unfit for tin-plating, 0.03 to 0.04% will render the tin quite brittle; in testing a bar containing, say, 0.04% sulphur, by nicking and bending the 'cry' will be dull, the fibre does not develop, and the bar breaks after slight bending. However, after so many years, I am not positive as to the exact percentage of sulphur.

Did you experiment with this scrap-iron?

Yes, I started the furnaces and made about three tons of

blooms one day. The iron worked beautifully under the hammer, and being at that time short of rabble-heads we forged a score or so. The next morning, on entering the forge, I saw several broken rabble-heads; they were so brittle that they broke in several pieces when dropped on the cast-iron floor-plates.

Was that due to tin in the iron?

Yes, in rolling the tin-plates after dipping, to remove the superfluous tin, a double or perhaps treble thickness forms on one edge of the plate. That thickened edge was our undoing; if we left the tin-plate scrap in the solvent long enough to dissolve the extra thickness of tin on the edge, sulphide of tin was precipitated on the larger portion of the plate, greatly reducing our tin recovery; furthermore, there appeared to be a sort of tin-iron alloy in the pores of the plates that could not be removed. This tin rendered the iron 'cold short'.

Did you try other means to remove the tin from the scrap?

Yes, and succeeded by using a weak solution of lime chloride as a dip, before feeding the de-tinned scrap to the puddling-furnace. This gave us a higher recovery of iron in blooms and quite free from tin, which latter was volatilized as chloride. We ran a batch of five tons of blooms, sold them to the tin-plate works, where they were rolled into plates and covered with our refined tin, thus realizing Mr. Parnell's ideal, but the blooming process would not pay.

What did you do with the iron after that?

The rabble-heads we made proved much superior to common iron in skimming furnace-charges, and we supplied the copper-smelters with rabble-heads at a good profit. Later, we sold them ladles of the same iron-tin alloy, beaten out under the steam-hammers and pressed into form in molds by the same hammer.

You spoke of blast-furnace smelting?

We smelted several thousand tons of tin-slag in our blast-furnace and did very well, using puddling-furnace cinders to break up the tin silicate and incidentally accumulated quite a bit of 'hard head', a tin-alloy, the subsequent treatment of which

caused more trouble than anything else about the plant. I left considerable of it for my successor to work up.

What about copper-matte smelting?

The business was controlled by a large firm of ship-owners who picked up cargo in various places and sent it to the Stannic works for reduction. I recall a large cargo from Algeria, containing gold, silver, zinc, and 2% copper. It was my first experience with zinc, and I had a very bad time of it with 12% in the charge. In the midst of my troubles your uncle, Richard White Rickard, dropped in; I believe the ore came from his mine; we became good friends and he proved a great help to me later; permit me to say he was a splendid engineer, one of the best informed men I had met and an all-round good fellow.

Did you remain long at Swansea?

After a year and a half my health suffered from the ever-present sulphur fume, so I left with the good wishes of the board, and a handsome testimonial from Mr. Parnell for "improving and completing his process". I returned to mining, accepting the management of the Glenariff Iron Ore & Harbor Co., in county Antrim, Ireland. The supervision of the extensive mines of aluminous iron ore, pisolitic, below the basaltic plateau, ten miles of railway, and the fascinating geology of the Glen kept me busy for a year, during which I published a paper on 'The Tertiary Iron Ores of Antrim'. Mr. Rickard next offered me the management of the Duchy Peru mine in Cornwall, of which he was then consulting engineer; so in 1881 I found myself mining zinc-blende with siderite gangue, hand-sorting the coarse ore and wondering what I would do with the fine, of which my predecessor left a large tonnage for good measure.

In what part of Cornwall was that?

The great Perran iron lode in the parish of Perranzabulo, about six miles from Newquay. Perhaps, Mr. Editor, you will recall that I first met you at that mine.

Indeed I do, and how kind you were in answering all my boyish questions. I remember also that the mine was exceedingly hot, and that I was awakened to an appreciation of the heat generated by chemical decomposition. If I remember correctly, you went soon afterward to New Zealand, on the recommendation of my father?

I did, but first I spent a year in London as manager of the Barking Metal Works. Antimony smelting and refining.

How did you like that position?

Very much, it was extremely interesting and instructive work. The smelting was done in crucibles, using salt-cake, and rich slag, with tin-plate scrap for desulphurizing; the product from the first smelting, called 'singles', was re-smelted with alkaline flux and excess of antimony sulphides, two buttons 'single' formed a crucible charge, the product was called 'doubles' or 'star bowls'. The 'doubles' were melted, and refined, with a special so-called secret flux, which was allowed to cover the plates in the mold to develop the 'star'. Our product was sold as French star antimony, and so far as I could see, it mattered little what the composition of the metal was, so long as it had a good crystallization on the surface—the much-desired 'star'. The refiner was a secretive, independent, and, in his cups, an insolent man. As he was inimical to proper discipline, I dismissed him, but before leaving he tampered with the refining flux. I promoted the man on the 'doubling' furnace to refiner, but he could not produce the 'star'; together we tried all sorts of mixtures of pearl-ash, adding various salts, including tin, which was believed to help the starring process, hence the use of tin-plate scrap in the first smelting. The third day we threw away the old flux and began experimenting with fresh salts, and with the knowledge and assistance of the new refiner soon produced the much-desired 'star'.

Did you introduce any improvements in the plant?

No, we were designing furnaces to smelt the ore in quantity and preparing to put in a lead stack for silver ores when the sudden failure of Richards, Power & Co., in 1883, closed up the works. Lord Penzance had the largest holding, but having been

misled by R., P. & Co., refused to continue operations. I realized on the stocks, the company was wound up, and I went back to Cornwall to pump out the Old Duchy Peru mine, just purchased by Brown Bros., of St. Austell.

What was your next move?

Your father, Thomas Rickard, kindly recommended me to the Kapanga Gold Mining Co., and I obtained the management of their mines at Coromandel, across the Hauraki Gulf from Auckland, in New Zealand. The Kapanga was a specimen-gold mine and the most disappointing that I have ever operated; I got the tail end of one small pocket and insufficient funds to find another. The only incident worth recalling is the discovery of auriferous native arsenic, the collection of, I believe, 350 lb., of this metal from the dumps, and extracting about 50 oz. of gold from it. The pin I am wearing is native arsenic from Kapanga.

You were not long in New Zealand?

About a year. I traveled a good deal, called at all the principal ports, saw some of the best mines, visited the hot springs and volcanic district, and greatly increased my knowledge of geology and mining. I spent a few weeks in Australia, on my way back to England.

What was your next move?

Some mine examinations in France; then I met one of the Brown Bros., who offered me the superintendency of a group of mines in Sonora, Mexico. The Los Bronces and Animas mines in the Barranca district.

In what year was that?

In 1886.

How long were you in Mexico?

Almost one year. The company operated under the name of the Silver Queen United. I found a concentrating mill under erection, and no water with which to operate it, and indeed very little ore either. I procured boilers, steam-pumps, and about three miles of pipe, unwatering three or four mines without filling the reservoir, but we finally got started and made very ir-

regular runs, because of the many shortages of ore and water. The last Rittinger percussion tables I saw in use were in this mill; we had, I believe, four of them. At Bronces the company had a dry-stamp mill and hyposulphite leaching plant. Realizing that the company had not obtained title to the property, and that its finances were in poor condition, I left at the first convenient opportunity and returned to London before the crash came.

What was your next position?

Consulting engineer to the Mountcashel Iron Ore Co., in Antrim, Ireland. I built a concentrating mill of 200 tons daily capacity to recover the hematite pisolites from the aluminous gangue. The plant was a success. In the same year (1886) I was appointed consulting engineer to the Société Anonyme de Plomb D'Asperieres, operating on the river Lot, near Capdenac, Aveyron, France. A large concentrator had been erected against my previous advice to the company, and it did not treat the ore satisfactorily. The silver-lead, carrying an ounce of silver per unit of lead, was as soft as graphite and was enclosed in quartz of the very hardest type; slime trouble was ever present and was never conquered, although the largest fixed Linkenbach tables I had ever seen had been put into commission to save the silver-lead in the slime. It was not much of a success. To crush the quartz fine enough to liberate the galena so that a 60% lead product could be made meant enormous losses, hence hand-sorting was pushed to the limit and a jig and table product sold running high in silica.

So that did not last long?

It did. The English people struggled along for about three years with it, when a clever Welshman, one Henry E. Fry, managed to sell it to the French, who operated it for several more years; but I doubt if anyone made it pay. I was in the midst of my work improving the plant when I was offered the position of manager of the La Plata smelter at Leadville, succeeding William Hanson.

He was a man of high character. I knew him well. He died in San Francisco in February last, having been for many years the manager of the California Wine Association. When did you succeed him, Mr. Argall?

In March, 1887.

What was the condition of the smelting business in Colorado at that time?

Very bad indeed; keen competition between the valley smelters and those at Leadville, and not ore enough to go around. Sulphide ores were coming in strong and the La Plata had no roasters; the blast-furnaces were small and obsolete; ore and charges were all handled by shovel and wheelbarrow. A large custom business was being handled at a loss. I piloted the old smelter along for a couple of months and, having worked out the smelting conditions carefully, I cabled my company to furnish $250,000 to re-build the furnaces, put in roasters, and generally modernize the plant or go out of business. The conditions were such that I could only promise 10% net earnings on the new investment, not on the entire capital. I confess to a feeling of relief when the directors decided to close-down the smelter and cut their loss; nevertheless the night we blew down the furnaces was a trying one for me. It seemed like a metallurgical funeral. I patroled the dump the whole night long, wondering if I had terminated a great industry that in other hands might have been profitable, or if I had rightly advised my company. A few days later this depression passed away with the full conviction that I had taken the proper course, and I have never since regretted my action. In the course of a few years other and better equipped Leadville smelters went out of business and for years past there has been but one smelter at Leadville.

The survival of the fittest?

Undoubtedly the largest, most modern, and best plant survived, the Arkansas Valley plant now operated by the American Smelting & Refining Company.

What became of the La Plata smelter?

I sold it to D. H. Moffat and associates. Pyritic smelting was introduced under the direction of W. L. Austin and was success-

fully continued under the management of the late Franklin Ballou, for several years. I had an opportunity of following the results during the trial-runs. The dust-loss at first was enormous; I was called in consultation, and designed dust-flues and condensing-towers in which the fume was washed with water, and thereafter the plant operated at considerable profit. Later, in association with Mr. Austin, I endeavored, without success, to introduce pyritic smelting elsewhere in Colorado. The La Plata smelter, partly re-built and enlarged, was afterward purchased by the American Smelting & Refining Co., and dismantled.

It was in 1887, if I remember correctly, that you examined the Rathgeb mine in Calaveras county, California, and were good enough to give me my first job as manager?

You refer to the Union Gold. Yes, I remember distinctly examining that property and later placing you in charge there, but the rest has passed like a dream. I can scarcely recall the developments.

When did you first become acquainted with cyanidation?

After leaving Leadville I had my first dip into the cyanide process. I had, of course, heard and read much about it, but for some time I considered it one of the humbugs. It was in the hands of people who did not inspire confidence, and who advertised the requirements of the process as a few old tubs, some mill-tailing, a chunk or two of cyanide, and a handful of zinc shavings. Strange to say, you yourself were the first man to place in my hands actual results obtained from the treatment of sulphide ores in Arizona.

I had quite forgotten that. The results to which you refer were those obtained on a pyritic gold ore from the Hillside mine near Prescott, then being worked by a flamboyant person called H. H. Warner, of 'Safe Cure' fame. But Mr. Argall, you became connected with the MacArthur-Forrest people, did you not?

Yes, when the late Thomas W. Goad obtained the management of the American MacArthur-Forrest Co., he virtually forced me to act in the capacity of consulting metallurgist to that company. My first task was to rectify the failure of the first plant

erected in the Black Hills: I can't recall the name of the mill but it was built at Deadwood by men from the Hill City tin mines. I believe it was in the winter of 1903. The ore could not be leached because dust and sand were treated together in the tanks and there was too much dust. Those in charge had imported a patent pulverizer from Grenoble, France, believing slime—I should say 'fine dust', for it was a dry-crushing machine—essential to good extraction. I had rolls substituted for the pulverizers, and with a few other changes the plant operated successfully. However, I reached the conclusion that slime and sand should be treated separately, so I designed a special machine for separating the dust from the sand in dry crushing, and used V-boxes to effect the same object in wet crushing.

What was the name of the dust-separating machine?

It had no particular name, but I patented it in 1904, also crushing in alkaline solutions, separating the slime or dust from the sand and treating each separately. The dust-separator has since been widely used in Western Australia and elsewhere.

You anticipated what later became standard practice, but how did you treat the dust?

This was my practice in 1894: the dust was moistened and run through a briquetting machine, the bricks stacked, dried, and roasted in the same way as common building-bricks are made, then broken up and cyanided. The extraction obtained from the roasted brick was so much better than that obtained from the sand, that it led to an investigation which subsequently caused me to introduce roasting as a preliminary step to cyanidation. The experiment made on the dust from Deadwood ore gave extractions of 96 to 98%, and those on Cripple Creek ores yielded similar results.

The briquetting and roasting had the effect of giving you a porous material, I suppose?

Yes, and setting free the gold from tellurium; the bricks were so porous that I have often obtained 90% extraction from an unbroken brick.

When did you go to Cripple Creek?

In January 1894, to investigate the failure of the first cyanide

plant in that district, afterward called the Brodie mill. Here the trouble was precisely similar to that at Deadwood. The charges in the tanks could scarcely be wetted, there was so much talc and clay in the dry-crushed ore. I pointed out the cause of the trouble and rectified it when enlarging the plant, which operated successfully for a year or two and was again enlarged.

What was the capacity of the Brodie mill in 1894, and what was the treatment charge at that date?

I left the Brodie mill with a capacity of 25 tons per day. The treatment charge on ounce ore was $15 per ton and we needed every cent of it.

You next built the Metallic works at Florence, I presume?

Yes, that was my next effort. The Moffat interests were building the Florence & Cripple Creek railroad and desired to have a large reduction plant near its terminal. I was sent for and found the directors prejudiced against cyanidation, because "the ore would not leach". On the following day, I made a stack of briquettes in a cupel-mold from the slime of Cripple Creek ore, roasted them, and repaired to the First National Bank with a pocketful of the roasted cupels, a small plate, and a bottle of water. I poured water on the plate and set the cupels in it; in a few minutes the water was all soaked up by the briquettes and I added more; when the water rose to the rim of the briquettes and began to fill the bowls, the directors were satisfied, and a week later the Metallic Extraction Co. was incorporated, and by June 1895 we were treating 3000 tons of ore per month.

That was the first large custom plant to treat Cripple Creek ore by cyanidation, was it not?

Yes.

How much of the ore purchased at that time underwent briquetting?

From 15 to 20%, depending, of course, on the crushing qualities of the ore, or the amount of clay or talc in it.

When did you begin roasting Cripple Creek ores?

During the winter of 1895, I modified one of my multi-

tubular driers and roasted and leached several lots of 25 tons each. We next purchased a Ropp roasting-furnace, the invention of Baron Alfred de Ropp, formerly manager of the Selby smelter. I believe ours was the first 'Ropp' used outside Selby; at any rate it was the first in Colorado. Afterward I used multitubular roasters of my own design. We then purchased all the oxidized ores available and treated them direct, but the recovery of gold from the roasted product was so superior that the roasting facilities were rapidly increased, and by the close of 1897 we had a capacity of 10,000 tons per month. This was a pioneer plant in the direct treatment of sulpho-telluride ores. Engineers and metallurgists came from various countries to study our methods, more particularly the roasting feature. We had several visitors from Kalgoorlie, notably from the Great Boulder Perseverance mine.

But you modified this method later?

By the time the roasting process was fully developed, it became apparent that we were placing the cart before the horse. In roasting the telluride, coarse gold, in shots and grains, was formed commensurate with the size of the telluride particles in the feed, pieces often too large to be dissolved in the time available for the leaching process; to avoid large particles we crushed finer, also placed riffles in the tailing-sluice. These riffles were effective in collecting the 'metallics' and also some of the unroasted sulpho-tellurides, but obviously the better method under our conditions was to grind still finer; that resulted in more dust, an enlarged bag-house, and general increase in the treatment cost. I then jumped experimentally to the other extreme, with the object of making all the coarse gold possible during the roasting process and recovering this coarse gold by amalgamation. Cripple Creek ore at that time contained about 2% sulphur, and I was able to make good extractions on 1-inch roasted cubes, but found that ore crushed to pass ½-in. round-hole screen when roasted gave almost perfect extractions by amalgamation and cyanidation. The results of several tests on 5-ton lots were placed before the directors, and a complete new plant decided on, embodying these features: crushing to pass ¼-in. round hole, roasting the ore at that size, fine crushing, and amalgamating the roasted ore in Chilean mills,

using weak cyanide solutions in place of water. Drying of the ore was avoided, also dry-crushing and dust-loss, hence a bag-house was not required. A site for the new plant was chosen at Canon City, and a branch of the Florence & Cripple Creek railroad was built to Canon City to accommodate the new plant.

In what year?

I believe work was begun on the branch in 1898 or early in 1899, but was suspended when the Moffat interests optioned their railway and the Metallic plant to those controlling the Midland Terminal railway, a rival line for Cripple Creek traffic.

Was the option taken up?

Yes, and the Metallic works passed into other hands, but I remained in charge until the close of 1900, in fulfillment of my contract. The new people naturally did not care to build new works and scrap or remove the plant they had just purchased for $600,000, so I refused to renew my contract.

Was it your purpose to scrap the Metallic plant?

Not exactly; the directors decided to erect a new plant at Canon City of 15,000 tons per month capacity, and when that was in successful operation, to remove the machinery from the Metallic, and ultimately have a plant capacity of 25,000 tons per month under the new process at Canon City at an estimated treatment cost 50% below our cost at the Metallic plant.

What was the cost of treating a ton of ore in the Metallic plant?

About $3.50, all-roasting, at 9000 tons monthly capacity.

How did you treat the 'metallics' caught in the sluice?

We first sold the heads to the smelters and sent the lower-grade back through the plant. Then I put in a small Chilean mill, amalgamating plates, etc., and ground fine, amalgamating the entire product. In this test-mill I also made my first experiments in amalgamating and cyaniding the coarse roasted Cripple Creek ore.

What became of the Metallic mill?

It was operated for about six months after I left; the new

owners helped to form the mill 'trust' or 'combine', in which chlorination was the dominant feature. The Metallic mill was sold to this group, closed down, took fire while being dismantled in 1904, and burned to the ground. Financial affairs often upset the best-laid plans of metallurgists, so because of financial backing, and not because of merit, the chlorination process reigned supreme for about six years.

But that did not end your connection with cyanidation, Mr. Argall?

No, I maintained my interest in cyanidation by frequent contributions to the technical press, by lectures, and in consultation work; such as in connection with the Dolores mine, in Chihuahua, and other Mexican mines, the ores of which I tested before outlining their proper treatment. I urged consistently that cyanidation was bound to supersede chlorination in the treatment of Cripple Creek ores: cyaniding was so much simpler, so much cheaper, and with the many improvements introduced throughout the vast regions tributary to cyanidation, the process would yearly become simpler, more certain, and cheaper.

Did you make any bromination experiments?

Only on a laboratory scale. The late H. R. Cassel was the bromine protagonist and a most remarkable man. I first met him in 1887 when he was building the Nelly Bly mill to exploit his bromine process in Boulder county. We next met at the Telluride mill, at Colorado City, afterward called the Golden Cycle mill. This was erected to treat Cripple Creek ores by leaching with bromine solution in open vats, displacing the bromine in the filtrate with chlorine and recovering the bromine for re-use. The evolution was from open vats to covered vats, covered vats to revolving barrels similar to those used at that time in the chlorination mills, and, lastly, to straight chlorination in the revolving barrels. J. T. Milliken, of St. Louis, having secured an option on a block of Telluride Reduction Co. stock, employed me to look into the process at the time of the trial run. I pointed out in a letter what I considered the weak points and advised him to not exercise his option. He followed my advice. A few years later, 1904, the plant went into the hands of a receiver; when at Goldfield, Nevada, an urgent telegram

[illegible] at once in New York for a [illegible] Milliken had handed [illegible] that it had been dis- [illegible] to be a fairly accurate [illegible] bromine process, so [illegible] advice. I examined and [illegible] and advised that [illegible] The large shareholders held some [illegible] they had had enough. I believe [illegible]. Toward the [illegible] working on an electro- [illegible] similar to the Clerici-Pelatan, in [illegible] solution, but the apparatus [illegible]

[illegible] this mill later?

[illegible] had purchased the old [illegible] introducing the [illegible] in 1899, with, of [illegible] in the interval. The [illegible] sampling and fine- [illegible] plant and storage- [illegible] without drying, to [illegible] fine, and amalga- [illegible] slime from the sand and [illegible] the plant, however. After a [illegible] the plant gradually forged to the front [illegible] from the field, so that for the last [illegible] supreme in the treatment of [illegible]

What is the present [illegible] Golden Cycle mill and the cost of treatment?

The mill is reported to be treating about 40,000 tons per month and is paying [illegible] per month in dividends on a capital of $1,500,000, or 24% per annum. The total gold production is in the neighborhood of [illegible], five times the total production of the Metallic Extraction Co. I have not seen any recent treatment cost.

What was your next important work?

I was very busy between 1903 and 1907, apart from the work noted, traveling extensively in Mexico on consultation work. One case of importance was at a cyanide plant where old tailing would neither leach, filter in a press, nor settle for a decantation. It proved to be a surface-tension phenomenon, cured by the addition of two pounds of sulphuric acid per ton of dry slime. An agitated charge, after 12 hours standing, gave less than one inch of clear solution; after acid was added, over six feet of clear solution could be drawn off under like conditions of time and charge. That was one of my best day's work; on leaving, I told the superintendent to cut down the acid after everything was running nicely; a year later I wrote to know how much acid he was using, he replied, "Two pounds per ton of slime. I tried to reduce the acid on various occasions, but the settling rate decreased, as did also the extraction". So in this case of arrastra tailing, acid increased the extraction and made decantation possible.

In the fall of 1905 I had charge of the field-work of the Zinc Commission appointed by the Government of Canada to investigate the zinc resources of British Columbia and test the ores to determine the best commercial process for beneficiating them. It took the greater part of 1906 to complete these ore-tests and prepare the report and maps. That work has been well received, and may be said to have stood the test of time, though the field-work was greatly rushed in an endeavor to get it finished before snow-fall.

When and how did you become connected with Stratton's Independence?

In November 1906, while in the Arizona desert, I received a cablegram from London offering me the position of consulting engineer, with special request to make prompt investigation of the best means for treating the big dumps at Stratton's Independence mine, at Cripple Creek.

Had any previous work been done on the dump?

Yes, Cassel had built a small testing-plant, introduced his electro-cyanide process and the Cassel filter process, in which latter the old Stratton's Independence company had an interest. Godfrey Doveton and others investigated this, the last of the

Cassel processes, and turned it down. Over $60,000 had been spent and nothing particular accomplished, except the sampling of the dump, hence the directors were very anxious for me to get busy and report. I started concentration tests in January 1907, and determined the recovery available by that method. Next, the recovery by cyanide from the tailing. I then fell back on long years of experience in arriving at the cost of the various operations, such as mining the ore from the dump, delivery of it to the mill, crushing, concentrating, cyaniding, treating the concentrate, and marketing the bullion. I cabled my results in March 1907, claiming a working cost of $1.52 on a basis of milling 10,000 tons per month. This, mind you, at a time when custom mills were charging $5.50 to treat a ton of low-grade ore. Of course, I laid myself open to criticism by stating that such ore could be treated on the mine for about one-fourth that cost, and I certainly received my full share of attention from the people that fail to advance with the times. It was a new problem, anyhow; it cost us $3.50 to treat a ton of ore at the Metallic works; here a profit had to be made from $3 ore.

I know you worked within your estimate for some years, but how did cost and extraction average over the milling period?

The milling of 671,665 tons in six years shows an average treatment cost per ton of $1.5138, and an average extraction of 74.57%, against my estimate of $1.52 and laboratory extraction of 74.22%.

The agreement between the figures is almost uncanny?

Perhaps it's a coincidence; the cost during the six years varied with the tonnage, the lowest annual cost being $1.38 on 133,875 tons; the highest, $1.79 on 68,711 tons.

You have had a long and active experience in the metallurgy of Cripple Creek ores?

It has been my privilege to see the cost of treating these ores by wet methods reduced from $15 per ton in 1893 to $3.50 in 1898, and to $1.38 in 1913.

Have you had anything to do with flotation?

Yes, quite a little. I was familiar with Henry E. Wood's

experiments and had read about the Elmore vacuum process. In 1907 I had an Elmore expert test a line of samples from the Independence dump. The results were very erratic and, on the whole, little better than those obtainable by water concentration. I had sufficient tests made to lead me to the conclusion that the Elmore process was of no use in treating that particular dump, which contained much oxidized stuff; furthermore, cyanide treatment of the flotation tailing was equally uncertain and invariably low. At first I attributed poor extraction to the acid, and later to oil, which I concluded interfered with the solvent action of the cyanide; so I dropped the matter in disgust.

What recovery did you obtain by the Elmore vacuum-oil flotation process?

Taking the more regular of the tests:

Ore	reduced	to	20	mesh,	34%	recovery
"	"	"	40	"	50	"
"	"	"	60	"	51	"

In the same year, 1907, I was investigating the ores of the Graphic mine, at Magdalena, in New Mexico, a very bad mixture of sulphides and iron oxides. Again I had tests made by the Elmore vacuum process, and the results were extremely erratic, but two tests gave a concentrate exceeding 40% zinc, one a 46% zinc concentrate, the highest-grade product secured up to that time. Several other tests gave only a 30 to 40% zinc concentrate with a very poor recovery. It appeared that the specularite in the ore became oiled under average conditions in the vacuum process and floated readily; on the other hand, much of the zinc failed to oil; consequently the majority of the tests gave unfavorable results. Still I believed that flotation offered the best solution, and advised the company to erect a small testing-plant, seven years ago.

But you have used flotation since?

Certainly, we have been floating these very ores for almost three years now, and I assure you we have one of the most complicated mixtures ever encountered, consisting of sphalerite,

intimately blended with magnetite, pyrite, pyrrhotite, specularite, galenite, and chalcopyrite in a lime and tremolite gangue.

What mine is it?

The old Graphic, now the property of the Ozark Smelting & Mining Company.

What method of flotation do you employ?

Surface-tension or 'film flotation', as I prefer to call it, in distinction from the 'scum' or 'froth' that is allowed to accumulate in a thick layer by other methods.

I understand that you use oil?

Yes, we use mineral oil, and that is, perhaps, one of the chief points of departure. We are pretty well out in the desert there and use Diesel engines for generating power, and have gotten the oil question down to the point where we use the same oil in the Diesel engine as we use in the mill for flotation purposes.

But I understood you to say that the result of the use of oil with agitation is to give a film rather than a froth?

Precisely, crude oil, or residuum, can scarcely be classed among the good froth-producers.

Do you make a froth?

No, the ore is agitated with oil and acid and presented in large open vats to a surface of briskly moving hot water, on which the oiled particles float away rapidly as a thin film, and the unoiled particles sink. There is no froth to be seen on the vats at any time.

What becomes of the matter that sinks in the vats?

It passes to other mixers and is given a second, third, and, if necessary, fourth opportunity to oil and float.

When the mixture of ore, acid, and oil is discharged upon the surface of the hot water in the vat, the oiled mineral forms a film, I presume?

Yes, a continuous film of considerable cohesion, but very thin. I might add that owing to the intimate mixture of com-

plex minerals we crush very fine; over 50% of the pulp will pass 200-mesh.

Which of the sulphides are found in the film on the hot water?

Mostly the sphalerite, with some pyrite. Pyrrhotite often favors sinking unless excess of oil is present.

Does that suggest that the sphalerite has a greater selectiveness for the oil than pyrrhotite?

I believe it does.

As you are crushing so finely, I presume that slime offers no obstacle to the operation of this process?

None whatever, the most marvelous recoveries are made despite the fineness of the pulp; both the highest-grade zinc and the highest recovery are obtained from *minus* 200-mesh pulp.

Can you give me any figures of actual extraction?

You scarcely expect a full answer to that question. I can, however, answer it in part without giving away any secrets. We make no recovery of zinc carbonates or oxides, but of the sulphides that are *minus* 200-mesh. Our recovery is around 95%, making a 45% zinc concentrate from 16% zinc ore in one operation. I have been astounded at the recoveries that it is possible to make from slime, by flotation methods. In slime treatment, I feel assured, the future of flotation lies.

Do I understand you to say pyrite, pyrrhotite, and other sulphides, except the zinc sulphide, sink with the gangue minerals?

I do not wish to convey that idea; pyrite is always troublesome, pyrrhotite less so, yet when the minimum amount of oil is used we do sink some of the pyrite and much of the pyrrhotite. Under certain conditions there appears to be a selective action for the sulphides in the order given. The ore is delivered from the mine to a breaking and sorting plant, where pyrite, other sulphides, and waste are sorted out as closely as possible on a picking-belt. The sorted ore is then conveyed to the mill, one mile distant over an aerial tram, and the remaining sulphides treated by flotation.

Do you have to re-treat your first film-concentrate?

No, just dewater it. The concentrate-overflow from all the vats is pumped direct to an Ovoca classifier, the overflow from which consists of dilute gangue-slime, all of which will pass 200-mesh and assaying about 3% zinc, while the concentrate discharged from the screws will average about 45% zinc.

How do you remove the specularite?

By strict adherence to film flotation. In the Elmore flotation specularite was taken up with the sphalerite in the mineral 'scum' or 'froth', perhaps on account of its high lustre. Specularite, though an oxide, is easily floated. Henry E. Wood tested the Graphic ore for me on his machine in 1907, using water only; the specularite floated beautifully, with some of the sphalerite. Mr. Wood said at the time that specularite was the only oxide he knew that would float in his process. Why we sink this mineral in our process is difficult to explain, but it is done.

What do you call the process?

The Ozark Flotation Process, worked out especially for these ores, and patented by W. Sydney Stevens of Magdalena. My firm is responsible for the detailed design of the plant and general supervision of its operation.

I recall your article on the occurrence of siderite in the Leadville ore, published in the 'Mining and Scientific Press' of July 11 and 25, 1914; has the discovery proved of economic importance?

There is yet no market for siderite carrying 20% manganese and 25% iron; siderite, however, is of great importance in prospecting for sulphide ores and occasionally for zinc carbonate ores; "no siderite, no sulphide" is now a recognized guide in prospecting in the White Limestone horizon.

The much debated and vexed question of the origin of the manganese in the oxidized ore, or 'black iron', of Leadville is finally settled. My reference to siderite as the source of the manganese in the 'Mining Magazine' of April 1914 was not fully convincing, but the second paper 'Siderite and Sulphide' has proved incontestable; furthermore I have recently found what I call the Rosetta stone of Leadville: a piece of siderite

colorless and unaltered at one end, passing into 'black iron' at the other, as a result of the oxidation of the siderite.

Have you made further researches on what you call 'vein' siderite?

I have, and find in every case that vein siderites carry high value in manganese; specimens from Mullan, Idaho, show as much as 25% manganese in siderite associated with chalcopyrite, magnetite, and quartz. The fact I endeavored to establish, that vein siderite is invariably manganiferous, may have wide economic importance.

Mr. Argall, you are now in consulting practice in Denver. I believe your sons are following in your footsteps? By the way, when were you married?

Some few years ago I formed a partnership with two of my five sons. The two partners are Philip Henry, who is a graduate of the University of Colorado and has practised in metallurgy for several years, four years at the Selby plant, part of the time as assistant-superintendent; and George, a graduate of the Columbia School of Mines, and now general manager for the Iron Silver Mining Co. at Leadville. We are consulting engineers to the latter company, Stratton's Independence, and the Ozark Smelting & Mining Co. I was married on August 31, 1876, in the sweet Vale of Avoca. My wife, who died in 1903, was the daughter of Capt. George Oates, a Cornishman with a long ancestry of miners, a man to whom I am indebted for much of my early training in engineering ethics.

You consider that our profession is still one that offers good opportunity to young men?

I consider that mining and metallurgy offer the very best opening to talented energetic young men, and the openings in the future will be far better than they have ever been in the past.

I remember that you received the gold medal of The Consolidated Gold Fields of South Africa, through the Institution of Mining & Metallurgy in 1903.

Yes, the medal and 40 guineas was unanimously awarded to me by the council of the Institution for my paper on 'Sam-

pling and Dry Crushing in Colorado', in other words, the mechanical treatment of ore by the dry process.

What do you consider your best achievement?

The introduction of the 8-hour working-day in Colorado mills, in the spring of 1899, at the Metallic works, without consulting my directors. It led to better work in time, to a better class of workmen, and a greater tonnage handled per man—in a word, to the elevation of our workmen and the lowering of the working cost.

LEARNING TO BE A METALLURGIST

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*In this issue we publish another of our series of interviews. The subject this time is Mr. Philip Argall, an engineer particularly associated in recent years with metallurgical work in Colorado. Our readers will find the interview deeply interesting; it is the record of a keen student, a hard-working man, and a resourceful manager. The term 'self-made' has been used too much, like the adjective 'practical', as an excuse for the shortcomings of the uneducated and the uncouth, so that it has lost its real significance, but if ever there was a man that hewed his way to success, that found the *carrière ouverte aux talents,* that owed little to good fortune and much to earnest endeavor, then Philip Argall is the man. Consider the beginning: the small boy that rummaged among the sluice-boxes and found a little nugget of gold, and in the act became infected by the longing to seek and to find, by that call of the mineral explorer that takes the adventurous to the ends of the earth and to the waters under the earth. The boy had an education that was not conventional; indeed, the shallow-minded might be inclined to say that if he had gone through the regular preparation of school and university he would have done better. We doubt it. Of education it may be said, as of many other things, that we get out of it what we put into it. To be among mines and smelters, to work in a concentrating mill, and to be in close touch with those actually engaged in winning the metals from ores is not necessarily a mining education, if the recipient be lazy or unobservant,

*Editorial in the 'Mining and Scientific Press' of January 22, 1916.

but to an alert mind eager to learn and anxious to become efficient, it is a veritable school of mines. Apparently the boy Philip had the happy gift of arousing the personal interest of his older acquaintances, some of whom took pains to help him by the loan of books or apparatus. That blow-pipe of which he tells us was the key to a whole world of rudimentary metallurgy, for a blow-pipe and a piece of charcoal constitute a blast-furnace in miniature. And then came the "complete laboratory" found at an abandoned mine. That was the luck of the miner, of course: of the energetic seeker and intelligent exploiter. Thus the awakened faculties were trained and developed. What could be a wider eye-opener to the mind of a keenly observant boy than the phenomena of kernel-roasting and the leaching of copper ore? The formation of a nucleus of copper sulphide in a lump of mixed sulphide ore is one of the most subtle of metallurgical operations; the leaching of copper ore affords a typical example of the impact between chemical and economic factors.

With adolescence came hard work in a mine, the learning of practical details underground, and the comparatively rapid winning of a post of responsibility. At 19 the boy Philip became the man Argall, for at that age he was appointed a shift-boss in the Cronebane mine. But routine work was not allowed to interfere with further study. Witness the detection of hydrogen as the cause of underground explosions due to gas arising from the precipitation of copper in the mine-water. Then came the designing of a brake on a whim: his first application of mechanical ingenuity, to be evinced during later years in the invention of a classifier and a roasting-furnace. And then, after 25 years in Ireland, Mr. Argall went to Swansea, which at that time was the Anaconda of Europe, as a centre of copper-smelting industry. But Swansea was reactionary and unprogressive, and in that respect wholly unlike the Washoe works; for that fault it has paid the penalty of becoming a melancholy 'has been'. However, in 1880 Swansea was yet in its glory as the recipient of all kinds of ores from every quarter of the world. And what was more important to the subject of our story, it was the locality chosen by Parnell for several ingenious methods of his own devising, including a complex copper process of the Hunt & Douglas type, now only of academic interest. One of Parnell's ventures was the treatment of tin-scrap, in which operation the

foreign to his own youth. Surely the United States has a good citizen in the man that has done so much to develop its mining industry and then contributes five sturdy intelligent sons to the community, not omitting the capable daughters, who, being voters in Colorado, are also citizens in good standing.

We like the choice of a "best achievement". Mr. Argall says it was the introduction of the 8-hour working day in the cyanide mills of Colorado. There speaks sympathy with his fellow-men; such a manager can get more effective work in 8 hours than can the small-minded autocrat who thinks the manual laborer is only a slave to be driven for 12 hours. But the dominant note in this fine career is expressed in the early part of our interview, where Mr. Argall acknowledges that he has been a student throughout his life. "Modern mining and metallurgy keeps one a continuous student, however humble his part." Yes, indeed; and not only in order to keep at the head of the procession but to enjoy that sense of useful power that comes to him who is gaining persistently in his understanding of the diverse operations of Nature. When John Richard Green, the historian, was dying, he asked that his epitaph might be: "He died learning". To be able to learn until the last summons is the wish of all thoughtful men.

JAMES L. BRUCE

AN INTERVIEW

Mr. Bruce, you are of Scottish origin?

Of Anglo-Scottish. The family home during my father's time was first at Shaw Farm in St. Quivox parish, and afterward at Rokeby House, near Prestwick, in Ayrshire, Scotland. My mother was born in Ireland, her father, William Latimer, being of purely English, and her mother of purely Scottish, origin. My two sisters, my brother, and I were born in Dublin, Ireland.

When?

I was born on March 20, 1880.

What sort of an early education did you have?

I attended kindergarten in London, England, for a year or a year and a half.

How did you happen to go to London when your home was in Dublin?

My father met with reverses of fortune during the panic of 1883 in Ireland and left for Ontario, Canada, to make a new home, during which time our family, with my mother, went to live with my mother's mother in London.

What further education did you have?

As a matter of fact, I had very little. Our family settled for a time on a farm near Haliburton, in Ontario, Canada, at a place without school facilities, so that the family's early education was confined to the home. My mother and an aunt from Scotland, who came to visit us for a time during my mother's illness, were our teachers. Later, when I was about nine years old, my mother having returned to my grandmother in London on account of very poor health, our home was made with cousins near Wood-

stock, in Ontario, where I went to a country school distant about a mile and a half from the farm upon which we were then living. I attended this school for about four years, after which my brother and I joined my father at Denver, in the fall of 1893.

What was your father's occupation?

My father spent many years, prior to the date of my birth, in Ireland, where he was engaged in the nursery, seed, seed-implement, and fertilizer business. He traveled through Ireland as a commission agent, handling the above and related mercantile lines, during a portion of this period. By the way, he was the inventor and patentee of special machinery used in the separation from each other of different species of grass seeds and in the elimination at the same time of weed seeds, machines of this make being supplied to several foreign countries, including France, Italy, Germany, and Austria.

So that is where you got your feeling for engineering?

I presume this is to some extent responsible. All my paternal ancestors on the Bruce side, as far back as my great-great-great-grandfather (1719), were Scottish estate-factors, and as such were necessarily engaged more or less in land-surveying, building of farm-steadings, road-making, and such work, but not one of them was a trained engineer in the modern sense. William Murdock, the inventor of gas-lighting and of several improvements to the steam-engine, was a member of our family, although I do not know the exact relationship. He was also, I believe, the first to install steam-engines in connection with mining, at Redruth, Cornwall, and was a partner of Boulton & Watt, of which firm James Watt was the inventor of the steam-engine. My maternal grandfather, William Latimer, an Englishman, was a civil engineer and was killed by a fall from his horse while engaged in building the first line of railway from Dublin to Belfast. His father-in-law, Thomas Millie, was also a civil engineer and died at Brockville, in Canada, while assisting in the construction of the Grand Trunk railway.

What took your father to Denver?

My father, soon after my mother's departure for London, removed to Florida, engaging for a time in the brick-making and

mercantile business, and later went to Denver, where he established a business, which was transferred to Cripple Creek immediately after the great fire which destroyed that place in 1896.

I can see that you were getting nearer the mines.

Although originally my father's business and not the mines had brought me to Colorado. While in Denver I attended the grade schools, and owing to unfamiliarity with United States history and other courses, it was necessary for me to start in the sixth grade. My advancement, however, due to my Canadian school training, was fairly rapid, and despite irregular attendance I was able, after going to school in Denver for a little more than two years, through the assistance of my brother, who had had more schooling, to prepare for entrance to the Colorado School of Mines, examinations for which I was successful in passing in 1896.

Your brother had preceeded you at the Colorado School of Mines?

Yes. He had completed most of his high-school course and had finished one year at the School of Mines at the time of my entrance.

What is your brother's name?

Stuart S. Bruce. He is now at Victoria, B. C.

You graduated from the Colorado School of Mines, Mr. Bruce?

Yes, I graduated in 1901, after having attended for the freshman and sophomore years, and thereafter remaining out for one year, during which time I assisted my father in his grocery business at Cripple Creek, to which he had removed from Denver a year previously.

So now you were actually among the mines?

Yes.

What were your first impressions of the mines? Were these the first mines that you had seen?

I had seen some of the coal and clay mines in the neighborhood of Golden before going to Cripple Creek, but had no familiarity or experience with metal mining, and, as a matter of fact,

my intention when I first went to Golden was to take the electrical engineering course, which was also included in the curriculum at that time, but coming in contact with mining people from various parts of the State and from other places created an interest in the mining industry which led me to take the mining course, this determination being made toward the end of my freshman year.

Why did you discontinue your work at Golden?

After having completed the sophomore year I found that my finances were insufficient to see me through the complete course and I found it necessary to go to work for a year and raise the necessary funds.

How did you do it?

I joined my father at Cripple Creek, taking up as much work as I could secure along my professional line, in assisting the mine surveyors and engineers of the district.

With whom did you work?

My first employment was with E. P. Arthur, in making the location of a mining claim called the 'Neversweat'.

That seems to be ominous of Butte.

Yes, I might add that the Neversweat claim was located on one of the hottest days ever seen in the Cripple Creek district. I also assisted Haff & Colwell, and, if I recall correctly, probably assisted, on one or two occasions, the firm of Hills & Willis, who were among the first engineers in the Cripple Creek district. I feel grateful to the members of the profession in Cripple Creek who gave me this first opportunity to get a start.

Then you went back to Golden and completed your course in 1901. After graduation where did you go?

My brother in the meantime had been employed by the Arkansas Valley smelter at Leadville as an engineer and through his good offices my first position was secured with Charlie Taylor, who had the contract for doing the assaying for the Ibex Mining Company.

The Ibex Mining Company operated the Little Johnny mine, did it not?

Yes, and this mine was one of the important producers of the Leadville district at that time. Mr. Taylor had the contract for all their work, at a flat price of $1000 per month, and through some development of friction in the organization, the shift-bosses and foremen were trying to overload the assay-office with samples. It is probably of interest to inform you that during one month we made more than 24,000 determinations for gold, silver, lead, zinc, manganese, copper, and silica, at an expense to the mining company of $1000.

How many of you were there in the assay-office?

There were, altogether, including the men who prepared the samples, seven men.

How long did this contract remain in operation?

Until after my departure; but the tremendous number of determinations gradually decreased in the four or five months during which I was employed there, to about 15,000 determinations —not samples.

How many determinations were made per sample?

Well; sometimes one, sometimes two, sometimes five or six. The average number of determinations per sample was probably about three.

What were you paid?

My average earning per month was between $80 and $85.

How much did it cost you to live?

Probably about $50 per month for the necessaries. I had no rent to pay.

Why did you quit?

In the fall of 1901 I had an invitation to take a position that seemed to offer better opportunities, with the firm of Hills & Willis in Cripple Creek, as draftsman and assistant to the surveyors and engineers, at a salary of $100 per month.

This gave you a good opportunity of becoming acquainted with the geology of the Cripple Creek district?

Yes; while I was principally occupied in drafting and platting of survey-maps, there were many occasions on which I was taken into the field, when I had an opportunity to gain experience in the practice of mining and in the operation of the mines and the geological side of the profession. I also had quite a little experience in preparing exhibits and assisting with examinations preparatory to apex litigation.

Do you not think that the surveying department is a good anteroom for a young mining engineer?

I think it is, provided the engineer doesn't develop, as frequently happens, a sense of satisfaction with this comparatively independent position, which will cause him to avoid the operating and clerical departments, thus depriving him of much of the experience that would equip him with qualifications for an executive position.

How long did you remain at Cripple Creek? Were you there during the big strike of 1903, and can you say anything about it?

I was assisting Mr. Hills in an examination of the Dead Pine mine, which connected with the Gold Coin workings, and we were engaged in that work at the time an explosive trap was discovered on one of the stations of the Gold Coin shaft. The railroad station at Independence had been dynamited, the militia had been ordered to the district, and a semblance of order had been established. The Gold Coin organization had discovered a box of explosives that had been arranged to cause a wreck of the shaft and station by a trigger so set as to be operated by the passing of the cages. The discovery of this probably brought about the more effective guarding of the properties of the various companies. Additional militia were ordered to the scene of trouble. I remember well that one or more machine-guns were trained by the militia on the approaches to the building in which our offices were located in Cripple Creek, as a protection to the Court in session in the same building, which was opposite the National Hotel.

What view do you take now in regard to that particular industrial trouble?

As I recall it, this was a strike that was called for the sole purpose of expressing sympathy with certain strikers at the mills of Colorado City, and I think there was no grievance with the conditions at Cripple Creek itself, and as various acts of violence had taken place it seemed to me that it was essential that peace be restored by armed force. One of the factors in the situation was the bellicose attitude of Sherman Bell, who commanded the militia. He seemed to be devoid of any sense of tact, and provoked unnecessary ill feeling by his truculent behavior. The ultimate outcome, however, was a co-operation of the mining companies in an employment agency, which probably brought about a more generally satisfactory contact between the employers and the employees than had previously existed.

Would that include the black-listing of the unruly or the anarchistic?

As to that I cannot say.

How long did you remain at Cripple Creek?

I left the Cripple Creek district in April 1904, in order to take a position with the Federal Lead Co. in south-eastern Missouri. This enterprise was then under the general management of J. R. Finlay, with whom I had previously become acquainted when he was general manager for the Portland Gold Mining Co. at Victor, in the Cripple Creek district. I had assisted Mr. Hills in preparing his portion of the annual reports of the Portland and had also given special assistance to F. L. Ransome and Waldemar Lindgren in the report that they made on the Cripple Creek district for the U. S. Geological Survey, and no doubt was suggested for the position by Alfred Rock, with whom I had become friendly while he was employed by the Survey at Cripple Creek, and who had accepted a position with the Federal Lead Co. before I went there. I also became a friend of L. C. Graton, who was assisting Ransome and Lindgren. I recall with pleasure the many good friends I made at Cripple Creek.

While at Cripple Creek did you go to any other mining centres?

I accompanied Mr. Hills as his assistant on an examination that he made of the Lustre mine at Magistral, near Inde, in Durango, Mexico. Inasmuch as this mine was about a hundred miles from the railroad terminus at Rosario and in a community of about 1200 people, with only 10 English-speaking people, it proved to be of unusual interest. The property was owned principally by Pittsburgh people and was under the management of Walter Koch, a delightful gentleman, who made the occasion a pleasant one in spite of the discomforts of a hot climate and an existence without such commonplaces as milk, butter, or eggs. A peculiarity of the property was that the ore was self-fluxing, and of a pyritic character, so that by semi-pyritic smelting there was produced a copper matte, which was shipped to the A. S. & R. smelter at Aguascalientes for further treatment.

So then you went to Missouri?

Yes. I accepted a position as engineer for the Federal Lead Company, although the compensation was considerably less than I had been earning at Cripple Creek.

How much?

I was earning $150 per month, and accepted the new position at $100 per month, as I was especially desirous of coming into more direct contact with the actual conduct of operations than my opportunities as a surveyor afforded with the engineering firm at Cripple Creek. I was an admirer of Mr. Finlay's capability as a mining administrator and was very glad to have the opportunity of working with him.

What was the nature of the mining operations?

At that time the scale of operations of the Federal Lead Company was not a large one and the property had not been developed to the point of profitable or large production. The ore deposits consisted of galena disseminated through limestone at depths ranging from 200 to 500 ft. The ores were concentrated on jigs and tables, the concentrate being shipped and treated at a smelter near St. Louis.

Did you remain long at Flat River?

I remained there until March 1907, first in the capacity of

engineer and after six or eight months as general mine-foreman, a position that brought me into intimate contact with the mining and milling operations. Mr. Finlay left a few months after my arrival and the management devolved upon T. F. M. Fitzgerald. During my employment as general foreman the properties of the Central Lead Company were purchased by the Federal Lead Company and a comprehensive program of new development and construction was undertaken, including the erection of a new concentrating plant. I was appointed chief engineer and co-operated in the erection of the new plant. I may mention that prior to this I was in charge, for a few months, of the diamond-drilling exploration of the company and so obtained a knowledge of that form of prospecting. It is interesting to recall that the mine shift-bosses at that time earned $2.40 per day, miners $1.90, pumpmen $1.60, machinists and blacksmiths $2 to $2.25, jigmen $1.75, mill-helpers $1.50, and surface laborers $1.30. The mill employees worked eight hours, and I believe the others worked ten hours per shift.

So your stay at Flat River was useful to you in enlarging your experience?

Yes, and also in increasing my friends among members of the profession. H. G. Washburn, who is now manager, came there at my invitation, as locating engineer for the Lead Belt Railway, which is owned by the Federal Lead Company and which at that time was being extended under my direction as chief engineer. This railway is one of about fifteen or twenty miles trackage; it serves to transport ore and supplies between the mines and mills and the Mississippi River & Bonne Terre Railway. L. G. Johnson, who at that time was my first assistant, is also still in a responsible position with the Federal Lead Company. Tom Hackwood, who was mill superintendent at the time I went there, later became assistant mill superintendent at the Butte & Superior during my management. His son, Arthur, who as a boy helped me with the surveying at the Federal, completed the mining course at Rolla and became chief research engineer at the Butte & Superior. W. S. Grether, who was also employed in the engineering department of the Federal Lead Company, after various experiences in other fields, again joined my forces at the Butte & Superior, and after taking charge of two or three out-

side operations for the company, now occupies the position of assistant mine superintendent. I greatly appreciate the loyal and capable support given me by all these friends.

While at the Federal it was my pleasure to establish a friendship with T. F. M. Fitzgerald, Corey C. Brayton, Frank Estes, H. A. Guess, C. V. Jenkins, Henry Krumb, E. G. Godshalk, H. A. Buehler, Allen H. Rogers, E. T. Stannard, and many others of the profession, the benefit of whose experience I have had on many occasions.

When did you leave Flat River?

In the spring of 1907. Upon Mr. Kirby's taking the management of the property I was not afforded the opportunity that I desired of again resuming a responsible place in the operating department. As I was offered a position about that time as assistant superintendent of the Grace Zinc Company, in the Joplin district, of which Mr. Finlay was president and general manager, I decided to accept it and went to Joplin in March 1907. I remained as assistant to W. H. Gross, the superintendent of the Grace Zinc Company, for a little more than a year, and in November 1908, the property being nearly exhausted, I accepted a position as manager of the Nortonia Mining Company, also at Joplin. This connection, however, being unsatisfactory—

Why was it unsatisfactory?

On account of the failure of the officers to provide funds to pay the crew.

You are excused. I have known what that means.

As a matter of fact, the property was in debt when I took charge of it. Shortly after starting up, the bank deposits were garnisheed by creditors, and upon the officers of the company failing to provide funds for payment of the employees, I produced sufficient concentrate to pay the men and, after shutting down the property, resigned.

Did you remain at Joplin?

Yes. Fortunately, within a few days thereafter I was invited to Boston for an interview with the officials of the Conti-

nental Zinc Company, who were then in need of a manager, Fred Jordan, the previous manager, having resigned to take a position in Canada. He is now with the Mesabi Iron Company and was at that time a good friend of mine, and in fact recommended me as his successor at Joplin.

Who controlled the Continental Zinc Company?

At that time it was controlled jointly by the firms of Ladenburg, Thallman & Co. and Hayden, Stone & Co.

So this time you had good backers?

Yes, indeed. I think this was the first mining venture of the Hayden-Stone organization, and for that reason they have always taken an interest in the property, which its size would not otherwise probably have justified.

What kind of ore deposits were they exploiting?

Their properties were producers of zinc and lead, occurring, in the case of the Litteral mine, as the well-known sheet-ground deposit of sphalerite and galena in chert layers within the limestone, at a depth of approximately 200 ft. By the way, we had some very low mining costs in connection with this property. In the face of difficulties encountered in pumping a strongly acid water, and unusual milling expenses due to its destructive action on all metal work, our costs of mining and milling, including all general expenses, for a year's operations, in 1912, were a little less than 85 cents per ton.

What was the grade of the concentrates?

The lead concentrate averaged a little more than 80% lead and the zinc concentrate about 57½% zinc.

Your production was concentrates? You did not treat either concentrate yourselves?

No, this was sold to custom buyers, as is usual in the Joplin district.

Did you remain long with the Continental?

I was in charge of the Continental operations until March 1913. On February 1, I was given leave of absence to assist Mr.

Finlay in a comprehensive examination that he was making of the properties of the St. Joseph Lead Company in the Flat River district, with which I had become familiar during my prior experience, and while so engaged was invited to a conference with D. C. Jackling, who was then developing the Butte & Superior property in Montana. I met Mr. Jackling and traveled with him in his private car from Kansas City to Topeka, and during the journey he suggested that I make a visit to Butte with a view to considering the management of the Butte & Superior.

What were your impressions of Mr. Jackling when you first met him?

I discovered very soon that he was thoroughly familiar with the technique of mining and in all respects a man of unusual capability. It appealed to me very much also to be afforded an opportunity to work for a man who would so thoroughly appreciate not only the accomplishments but the difficulties of the management of a mining property, and I had no hesitation, as soon as I learned that Mr. Finlay could release me without embarrassment, in coming to Butte to review the situation. This I did at the earliest opportunity, arriving in Butte some time during the latter part of February 1913, spending a few days at the mine and mill, after which I returned to make arrangements for my successor at the Continental Zinc, and to move my family to Butte.

When were you married?

I married Miss Mary Louise Temple, of Joplin, on June 16, 1909, and had the very sad experience of losing her on our fourth wedding anniversary, shortly after coming to Butte. On December 25, 1915, I married Miss Leah Sidney Hills, the daughter of my former chief, Victor G. Hills, of Cripple Creek. We have four children, two girls and two boys.

So you took charge of the Butte & Superior just about the time the flotation troubles began?

Yes. Shortly after the filing of the suit, which occurred in 1912. Mr. Hyde was still conducting experimental work at the Butte & Superior mill, but left shortly after my arrival.

Mr. Bruce, you had a great deal of experience in mining litigation of one kind or another, and the lawsuits both with the Minerals Separation company and the Clark estate must have added a great deal to your anxieties as manager of the Butte & Superior?

Yes, these controversies occupied a great deal of my time and attention; they occasioned a lot of traveling and my attendance in each of the Federal courts.

Do you look upon these litigations as unnecessary evils? That is, do you think that either the apex suits or the flotation suits could be avoided if the laws were revised?

I think that the revision of the apex laws could be beneficial only to future mining locations, inasmuch as they could not be made retroactive, but I think nearly all of our profession are agreed that some modification of the laws should be effected for the benefit of future locators and their assigns. The advantages or encouragements afforded by the law seem to be very much more than offset by the uncertainties and tribulations arising from its interpretation. With respect to the patent laws, it seems to me that while it is certainly desirable to encourage invention through patent protection, there should be some limitation not now afforded by the law from monopolies that may be created thereby.

Do you think it is possible to effect a settlement with the Minerals Separation people so as to relieve the mining industry of the incubus of their harassment?

It seems to me that the situation has become so complicated and the disposition of the Minerals Separation Company to exact punitive penalties from alleged infringers so stubborn that there is little probability of a settlement. The difficulty of securing a satisfactory co-operation of the mining operators is also a serious obstacle. It really looks very much like an almost endless campaign of litigation, unless the royalties demanded by the Minerals Separation people are reduced to such a figure as will induce the mining industry to pay them on those processes on which they claim patent protection.

You suggest that the M. S. people might become more reasonable —that is, that they might become so reasonable as to cause mine operators to accept their royalties without further antagonism? Do you think this is likely?

My view is that further litigation will establish the weakness of their position, which will ultimately provide the industry with clear-cut methods of escape by means of non-infringing processes.

I think there is a good deal in what you say. Some of their basic patents will shortly be expiring and meanwhile the continued research is leading to the discovery of methods for avoiding even the alleged infringement of their patents.

I believe that the process used today at Ray, known as the oiled-air process, is not an infringement of the M. S. patents. I think that this, with other known processes of highly efficient character, will not be found by the Courts to infringe.

It has been stated in print that the mining litigation at Butte has led to the discovery of important orebodies; indeed, that the discoveries have involved so large a tonnage of ore as to pay for the cost of the many litigations, but while I have been in Butte I have been told, by Professor Clapp of the School of Mines, for example, that this is not so, and that the amount of ore discovered does not begin to compensate for the money wasted in litigations. What is your view of this?

I think it is doubtful whether the discoveries of ore as a result of development litigation have re-paid the cost of such development work. There may be a near approach to it in some cases, but I think it is certainly true that the entire cost of litigation has only in rare cases been re-paid by the discovery of ore. In the case of the Butte & Superior litigation there was probably very little ore developed that would not have been opened up in the regular course of events, so that the cost of litigation, to both parties, amounting to probably not less than a million dollars, was practically uncompensated.

While you were in charge of the Butte & Superior you had labor trouble of a serious character in Butte, affecting your own management, I suppose. Would you please state the origin of these troubles, and what you consider the best means of preventing their recurrence?

The labor troubles in Butte have been occasioned, in most instances, by jurisdictional disputes between unions, or by the agitation fomented by outside organizations. They have seldom arisen from disputes between employer and employees. The first troubles with which I am familiar in the Butte district arose in 1914 from mismanagement of the local officials of the Western Federation of Miners, which brought about dissatisfaction of the union members with their own organization and resulted in its being broken up by spontaneous opposition of the rank and file. Advantage was taken of this situation by the organizers of the I. W. W. and the other extremists to secure control of the unorganized opposition to the Western Federation. The maintenance of this control during the period of the War, due to shortage of labor and high wages and lack of effective law enforcement, was easy.

But why should a squabble in the ranks of the union cause the men to strike, that is, to quit work?

Most of the strikes in this district have been brought about by the intimidation of employees, who have not been afforded sufficient protection, and who have a natural reluctance to continue at work in the face of threats and abuses directed not only against them personally but against their families, because they do not align themselves with the malcontents.

Your explanation applies to the strike of 1914, but how about the more ugly troubles of 1917?

The same statement applies to that. This strike was fomented by an electrician by the name of Dunn, who, it is presumed, had financial support from the headquarters of the Non-Partisan League or the I. W. W., and this probably instigated by pro-German propagandists. The finances supplied him were sufficient to enable him to establish a newspaper in the district, which secured the support of all the radical element. Dunn, for

a time, was successful in securing a large following and in organizing a gang that was efficient in conducting sabotage, and, after the strike-call, intimidating the great majority of the miners and craftsmen, who would have been satisfied with conditions if permitted to continue their employment undisturbed.

Was the alleged cause of this strike a quarrel between unions, or did it arise from complaints as to the manner of employment?

The principal demands of the striking miners included the recognition of the Metal Mine Workers' Union, known with certainty to be under the domination of the I. W. W. organization, demand for higher wages, abolishment of rustling cards, etc.; but inasmuch as the strike was called shortly after the declaration of war by the U. S. and about the time of the draft calls, it seems clear that it was undertaken in response to systematically organized propaganda to obstruct the preparations of the War Department. A scarcity of labor and an expansion of industrial activities, of course, brought a ready response to any demand for higher wages or shorter hours. Shortly after the call of the miners' strike sympathetic strikes were called by the electricians, machinists, boilermakers, and blacksmiths. The Metal Mine Workers' Union was not, however, recognized by the operators, and practically all employees had returned to work within a month after the date of the strike call.

What further strikes of importance have been called?

On April 18, 1920, a strike was called by the local No. 8 of the I. W. W. The demands made at that time, however, were very clear evidence of the fact that the strike was not called with the expectation of reaching any agreement that would better the conditions of employees. Demands called for a minimum wage-scale of $7 per day for six hours work, and the release of all industrial and political prisoners, and other features which manifestly were not within the power of the mining companies to meet. No doubt the I. W. W. organization at that time considered that there was a reasonably good chance throughout the United States of creating sufficient discontent to cause the initiation of revolutionary acts.

Do you think that the relations between managers and men at mines have improved or otherwise during your personal experience in the West?

I think they have improved. Of course, the tendency of the growth of larger corporations has been to separate the employees from as direct contact with the management as they used to have in the earlier days, but within the past few years much better consideration has been given to the welfare of the employees, improvement of their working and living conditions, provision for their representation, and the hearing of their grievances and suggestions. Nearly all of the larger companies, where the management does not come in direct contact with the employees, have well-recognized means of giving them representation.

Have you noticed the difference in the composition of the working forces in regard to changes of nationality or race?

Since I came here in 1913 there have been appreciable changes in the relative numbers employed of different nationalities and in the average ages of employees. Most of these changes are such as would naturally have been expected as a result of the War. In March 1913, of all employees in the Butte mines, approximately 35% were native-born and 65% foreign-born, as compared with 33% native-born and 67% foreign-born in the fall of the year 1918. In 1913 the proportion of foreign-born employees who had become naturalized was about 54%, as compared with only 37% in the fall of 1918. The proportion of employees in 1913 under 30 years of age was about 40%, as compared with a little less than 30% in 1918. In 1913, of the total number of foreign-born, about 65% came from English-speaking countries, while in 1918 there were only about 45%, the decrease being no doubt due largely to the demands of the War. Aside from the English-speaking workers, the principal foreign-born employees come from Austria-Hungary, Finland, Italy, and Sweden, with a scattering from almost every other European country.

What opinion do you hold as to the advisability of college graduates working up from the ranks, that is, engaging in manual labor underground, becoming foremen, and so advancing to positions of greater responsibility? Do you think that it is well for college graduates to go through this experience? Is it good for them, and is it good for the industry?

That depends entirely upon the individual. Some college graduates are so constituted, physically and mentally, that they pursue this course with credit to themselves and with benefit to the mining industry, arriving at positions of responsibility. Very many, however, are not so constituted as to survive the physical hardships of such a course without detriment to their mental progress, and I would not at all generally recommend this program. I think that a modest amount of underground practical experience would be of benefit to the majority of technically trained engineers, but in my experience the chief omission in their education is in business training, rather than in practical experience. I believe that contact with business men of experience and with business conditions can best be brought about in general by encouraging the graduate engineer to take a serious interest in matters of public and civic character.

Do you think they ought to learn something of accounting, bookkeeping, and economics, rather than thump a drill?

I think that this would usually benefit them more.

So you think, Mr. Bruce, that our young engineers should show a greater interest in civic and national affairs?

Yes, I certainly do. I think that they need more contact with men of experience in business methods and the advantages of the second-hand experience that would be gained by such contact. This can best be acquired by active interest and attendance at the meetings of organizations of a civic or business character, such as Chambers of Commerce, School Boards, Y. M. C. A.—in fact, any well-organized institution that performs its functions in a systematic or parliamentary manner.

Returning to your own career: How long did you remain with the Butte & Superior as General Manager?

Until January 1, 1920. In the middle of September 1919, I accepted the management of the Davis-Daly Copper Company, and acted as manager for both properties until the end of the year, at which time my resignation as manager of the Butte & Superior became effective.

Why did you resign?

There were several reasons: In the first place, I had an opportunity to take the management of the Davis-Daly at an attractive remuneration, and, in the second place, I was desirous of obtaining new experience in the copper industry, after having spent some years in the mining of lead and zinc ores. Furthermore, the amount of my attention that had been required by the comprehensive litigation of the Butte & Superior had become distasteful, and, while my associations and responsibilities as manager of the Butte & Superior had at all times been extremely pleasant, the new opportunity appeared to offer a chance for experience in a fresh direction.

I am glad to hear that you think you can escape litigation anywhere in the Butte district!

Well, I don't think that can be assured!

While you were with the Butte & Superior you examined a good many mines in various districts, did you not, for that company?

Yes, I made a number of examinations, and some of the properties were taken over and operated for a time. Among those operated were the Hudson Bay Zinc Co., near Salmo, B. C.; the Metalline Falls Zinc Co., near Metalline, Washington; and a large group of leases and options directly north-east of the Picher Lead company's holdings in the Miami district of Oklahoma. I also examined the Interstate-Callahan, the Success, and the Black Horse properties near Wallace, Idaho; a zinc property in Inyo county, California; copper prospects on Valdez Island, B. C.; and a number of properties in Montana. I also acted for a time as consulting engineer to the American Zinc, Lead & Smelting Co., and made examinations of their properties in the Joplin and Granby districts, Missouri, and at Mascot, Tennessee. At this time I

became well acquainted with H. R. Kimball, J. N. Houser, H. I. Young, W. F. Rossman, and W. G. Swart, who have been my good friends and counselors since.

Do you believe it to be a wise thing to perpetuate the organization of a mining company by the acquirement of new property, and also for a company to spread its activities so as to average its risks?

Yes. Any well-organized mining company is in a position to utilize its existing organization with comparatively small additional expense as compared with a new organization, and with much better efficiency, in taking up new properties that may show promise. As to the spreading of risks, although it is worthy of consideration, it doesn't appeal to me so strongly, as I feel that the individual stockholder, unless altogether uninformed as to the character of his investments, can spread his own risks by investments in the stocks of various non-attached mining companies.

Is the Davis-Daly Copper Company an old enterprise?

As a producer of consequence it has existed only since 1915, but following its date of organization, in 1907, an active program of exploration and development work was conducted. The principal orebodies, however, were not discovered until considerable depth had been reached.

How deep?

The first really important discovery was made at about 2500 ft. This ore has been followed to higher levels and has been the chief source of production since its discovery. Little development below this depth has been done, and the deepest development of ore at this time is on the 2700-ft. level, the shaft being 2850 ft. deep. The 2700 level, however, is equivalent to a depth of nearly 3200 ft. in some of the shafts situated on higher ground.

Do you think that the difference in elevation affects the nature of the ore deposits?

I think that the ore deposition in the deeper levels of the Butte mines is not affected by the surface contour. I come to this conclusion from the fact that the oxidized surface ores persist

to less depth at the lower surface than at the higher, and observations seem to show that the rock temperatures are about the same at the same horizons irrespective of surface elevations.

You have a cheerful feeling as to the future of mining in Butte, despite the present depression?

Yes, I can see no reason why the orebodies should not be mined as deeply as is possible within the limits of economy. Of course, as the temperature increases and ventilation becomes more difficult and hoisting more expensive, richer ores will be required to meet the cost.

What is the depth of the deepest workings, and what is the temperature at that depth?

The deepest shaft is the Steward, of the Anaconda Copper Mining Co., which is now 3633 ft. below its own collar and 3838 ft. below the collar of the High Ore shaft, with which it is connected. The deepest ore developed is about 75 ft. above the bottom of the Steward shaft and at an elevation of 2354 ft. above sea-level. In the deeper levels of the Butte mines when they are first opened the rock temperature is about 103° to 104° and in some cases up to 110°F. Some rock temperatures in the district are considerably higher than this, but only in the vicinity of underground fires.

The persistence of ore in the Butte district has been remarkable. You consider the prospects are still good for further persistence? Of course, by ore I do not mean vein-matter, but mineral that can be exploited at a profit.

Yes; I know of no district in which there is greater probability of continuance downward of the orebodies. Of course, not all ore-shoots have continued to go downward, but the number and importance of ore-shoots at the greater depth does not seem to diminish.

You have done some interesting work at the Davis-Daly, as I happen to know. Would you say something about your octagonal shaft?

We have just completed a unique shaft, exclusively for ventilation. This was raised from existing underground levels of

the Colorado mine from a depth of 1800 ft., and the work, including about 600 ft. of cross-cutting, was completed in a little more than five months, at a cost of about $71,000.

Is this shaft brick-lined?

When considering the ventilation, the proposal was made to construct a circular concrete-lined shaft, so as to give the least area of resistance to the air, relative to the area of the cross-section. This, however, was considered impracticable, from the standpoint of time and expense. A substitute was devised, however, and an octagonal cross-section was adopted, with timber bricking constituting the sides of the octagon.

What do you mean by "timber bricking"?

The lining was constructed of blocks of wood approximately 8 in. wide by 10 in. deep by 3 ft. long, with a specially devised framing to fit the ends together in a proper manner to support the pressure, giving a smooth-lined, timber-cribbed, or bricked shaft, free from posts or lagging.

What is the diameter of the shaft?

The minimum inside diameter of the octagon is 6½ ft. This has an area of 34½ sq. ft., and gives approximately the same air-capacity as a smooth-lined two-compartment shaft with an area of 45 sq. ft. in the clear. The amount of timber, however, that would have been required for the two-compartment rectangular shaft would have been 72% greater, and the amount of excavation 50% greater than with the octagonal shaft. The cost of timber used in the main section of the shaft, at a price of $37 per M, including all temporary timber and the cost of framing, amounted to only $11 per foot, which is less than the cost of timber for the regular 5-ft. sets in a standard two-compartment shaft, using 12 by 12-in. wall-plates and end-plates.

How much less?

About 80 cents per foot of shaft.

Would you tell me something about your sorting-plant?

There is nothing very unusual about that. The skips of ore are hoisted and dumped into a small hopper, feeding directly in-

to a mechanical grizzley of the Sheridan type, which is constructed of bars, the alternate members of which are operated by two sets of eccentrics, one set of bars raising the coarse ore, carrying it forward and depositing it on the other set of bars, which in turn repeats the performance, the fine passing through and the oversize being fed at a fairly uniform rate to a slow-moving belt-conveyor, with a speed of 30 ft. per minute, which acts in the double capacity of a distributing conveyor to the bins and a sorting-belt, from which the waste is removed by hand and the remainder of the ore separated into 'high-grade' and 'low-grade'. The ore as it is hoisted is classed as first-class or second-class and the fine of the one separated from that of the other by a swinging door placed beneath the grizzley. It has been found that the ore can be sorted at the rate of two skips, each containing 3½ tons, every five minutes, at a low cost and with good efficiency.

What is the low cost? That is, from mine to shipping-bin?

The cost per ton of ore hoisted is a little less than 8 cents, there being about 10% of waste removed, the remainder usually being divided into nearly equal quantities of first-class and second-class.

You have seen a good deal of improvement in safety precautions in the mines of Butte, and I presume that you have been glad to further this improvement?

Yes. At the Butte & Superior property our organization developed some protective features that were unique. One of these was the system of signaling to employees underground in the event of fires or dangerous gases, by means of the introduction to the compressed-air lines of volatile substances such as valerianic acid, which would permeate the air in the underground workings with significant odors. I believe this was the first development of this practice. The idea originally suggested itself to me that the arteries of air-lines throughout the mines should be an almost ideal means of distributing signals, and we endeavored at first to develop some electrical warning, without, however, arriving at any satisfactory solution. I think it was my suggestion thereafter than an odor in the form of gas be introduced into the air, and the research department, under the direc-

tion of Arthur Hackwood, working on this idea, suggested the better plan of using essential oils or liquids, and discovered the good qualifications of valerianic acid. This is fed into the air-receiver on the surface with a gravity-feed lubricator.

Has the U. S. Bureau of Mines availed itself of this interesting information?

I understand that they have made some experiments and developed other suitable reagents. Another interesting development in connection with safety measures was the introduction of stations or chambers underground. At a small expense, short lengths of old cross-cuts or drifts were partitioned off, with a door in the partition, and compressed-air lines carried into such stations, and, when available, water-lines, so that men finding themselves about to be cut off by dangerous gases may take refuge in the stations and prevent the entry of such gases by closing the door, this being made air-tight by calking with oakum, which is kept in the station. The exclusion of gases is further ensured by opening a valve in the compressed-air line, which furnishes the miners with fresh air and forces air from the station into the adjoining workings. When water-lines are not available, barrels of water are usually kept on a truck at the entrance to the stations. Such stations are marked with a sign or red light and are well known to all the employees.

Those are both interesting safety measures. Have you any others?

There were many others adopted. It was a rule of the organization that all shift-bosses must have taken training in the use of air-helmets and in first-aid. Water-pressure lines were installed down the shaft and in stations, and many other provisions made for the safety of men underground. The two first mentioned, however, are the only ones that are worthy of mention.

Do you consider mining today still affords a good career for young men?

Yes, I think that as the mining industry finds more difficult conditions to cope with, as it necessarily must, the demand for

engineering ability will become greater and the status of the mining engineer will continue to improve.

During your management of the Butte & Superior you must have had an opportunity, partly owing to the two big litigations, of becoming acquainted with a large number of professional men of high standing?

It was my pleasure to become acquainted with, as witnesses and counsel during these two lawsuits, many of the prominent and capable professional men of the day. Among the mining engineers there were J. W. Finch, D. W. Brunton, Albert Burch, Walter H. Wiley, W. L. Creden, D. C. Bard, Sam Barker, Carl Hand, W. H. Emmons, R. D. Salisbury, witnesses for the Butte & Superior, and H. V. Winchell, Professor Kemp, Fred Searls, Professor Irving, Rush White, the late Fred Green, Professor Leith, witnesses for the Clark interests. It has always been a source of gratification to me to feel that my organizations both at the Butte & Superior and the Davis-Daly were constituted of as capable, as loyal, and as energetic a personnel as can be desired. I am under obligation to almost every one of them for the support and assistance given me. Especially do I appreciate the helpful assistance and friendship of Charles Bocking as assistant manager, who succeeded me as manager; Angus B. McLeod, the mine superintendent (both of whom occupied these positions during my entire term); and of F. T. Wicks, J. T. Shimmin, and E. V. Daveler, successive mill superintendents, as well as many others that I would like to mention by name were the list not so long. Among those now in the Davis-Daly organization are several who served with credit at the Butte & Superior, including J. W. Dudgeon, chief engineer and geologist; B. F. Evans, efficiency engineer; L. S. Farnham, mechanical engineer, and S. A. Worcester, mechanical foreman. These men, together with Dan McGrath, mine superintendent; Clint Hansen, geologist; R. H. Barclay, construction foreman; J. E. Murphy, auditor; and B. A. Tower, mine engineer, have earned much credit in the conduct of Davis-Daly affairs.

Have you any ideas in regard to the education of young men for a mining career?

I think the tendency of mining schools of the day is to em-

phasize too greatly the value of experience gained in practical ways, in mining and metallurgy, during school years, and that more attention should be given to a thorough understanding of basic principles. A fair amount of contact with actual operations is desirable, chiefly for the reason that it stimulates keener interest, but the amount of experience that can be obtained during these years is so small, compared with what must be later undergone, that it is of little consequence if it means a sacrifice, as it frequently does, of a proper training in the fundamental subjects.

THE MAKING OF A CAREER

*The mining profession is remarkable for the variety of men it includes and the diversity of the training that they have undergone. As all roads lead to Rome, so all kinds of preparation seem to have sufficed to develop the character and stimulate the ability of the young engineer to such a point as to open the portals of a successful career. Presumably the correct inference is that force of character cannot be gainsaid if opportunity be given. The many interviews that we have published show that the leaders of our profession have been most variously, and, sometimes, it may seem, unequally educated, in so far as a conventional curriculum is implied; yet the inequalities of the start—the varying handicap, as it were—have failed to hold back the genuine men, the hard workers and honest thinkers, the true votaries of science as applied to industry. We have recorded conversations with those who were graduated from famous colleges and with those who as boys thought themselves lucky if they could get hold of an occasional textbook for reading during the intervals snatched from manual labor. Not many of our subjects have been graduates from recognized mining schools; partly because the School of Mines as an institution for preparing mining engineers was only just becoming established when our veterans were boys. Nowadays every civilized country has a School of Mines, and we in the United States can boast one in each of the principal mining regions. Among these is the Colorado School of Mines, which, despite its checkered career, has produced many useful

*Editorial in the 'Mining and Scientific Press' of September 10, 1921.

men, among whom is Mr. James L. Bruce, whom we interviewed recently in his office at Butte, Montana. From Dublin to Butte does not seem a far cry, thanks to Marcus Daly and other Hibernians, but Mr. Bruce only happened to be born in Ireland, and it seemed extremely unlikely forty years ago that he would ever develop into a leader among mining engineers in Montana. He owed his liking for mechanics to his father; and to that parent's migratory life he likewise owed his first contact with mining, in Colorado. There he became attracted to the digging of ore by meeting those who were engaged in the industry at a time when the goldfields of Colorado, particularly Cripple Creek, were in the ascendant. Like other successful and useful men, he worked his way through college, that is, he earned the money needed for the purpose, interrupting the regular scholastic course in order to engage himself as a chain-man and draftsman with a firm of surveyors at Cripple Creek. Such breaks in a college course may be a handicap in some ways, but they do serve undoubtedly to add to the seriousness of purpose with which the student renews his studies. Like everybody else he obtained his start through the kindness of a senior; we all did that; none of us was worth his salt when he started; somebody had to be a fairy godfather to us. Not everybody, however, remembers and records his gratitude, as Mr. Bruce has done, to those who gave him his first chance.

The surveying department is a good antechamber for mining engineering, if the young man be not too content to remain there, because it brings him in contact with operations underground and gives him an opportunity to study the structural relations of ore deposits. Mr. Bruce seems to have had a persistent desire to avoid undue absorption in the purely technical work, and to acquire knowledge of the business of mining in its broadest sense, more particularly in connection with the management of men and the administration of affairs. For his flair in this direction he may be indebted to the Scottish factors from whom he is descended; at all events, he showed early a keen appreciation of the basic idea that the chief purpose of mining is to make money, not to test interesting processes or to investigate the origin of ores, neither to develop the waste places of the earth nor to spoil the scenery of the beautiful ones. This being his notion, he was fortunate in becoming associated with Mr. J. R. Finlay, who in practice and in theory, as his book on 'The Cost of Mining'

proves, is a disciple of the truly utilitarian phase to which Mr Bruce was an early and sagacious convert. Then he met another, and even more famous, exponent of the same school, Mr. D. C. Jackling, one of the great captains of our mining industry. That was a turning point in his career, and it was only eight years ago, yet since then Mr. Bruce has achieved a notable professional success as manager of the Butte & Superior. Of course, the introduction to Mr. Jackling and the offer that followed was one of the opportunities that make a man's career. The point is that Mr. Bruce was ready for the opportunity, and was quick to recognize it at its real value. Our readers will be pleased with his unequivocal answers to our questions, particularly in regard to apex litigation, Minerals Separation, labor troubles, and other matters of a delicate nature.

Mr. Bruce denies the pleasant story, often repeated, that the cost and annoyance of mining litigation at Butte has been much more than compensated by the large orebodies discovered in consequence of work done underground for the purpose of obtaining evidence for use in the courts. He gives a clear—and, we believe, fair—explanation of the cause of labor unrest at Butte, where the usual issue between capital and labor has been confused greatly by the rivalries and squabbles of opposing parties within the ranks of labor, this confusion being caused chiefly by the radical and irresponsible element typified by the I. W. W. Of the so-called welfare work he approves, and more particularly the current practice of giving employees some regular means of representation, whereby their just grievances and desires can be brought before the management; but he recognizes, as others experienced in such matters have done, that the mere bigness of the modern industrial enterprise, in mining as in other branches of organized human effort, tends to separate the employee from direct contact with his employer, and thereby to spoil the human relationship on which effective leadership and successful co-operation may depend. Another change prejudicial to a mutual understanding between manager and men is the withdrawal of many of the native-born from mining, especially from work underground, and a proportionate increase in the foreign element. In some mines this involves the difficulty of speech, for many of the aliens do not speak English, and under such conditions it is doubly difficult to create anything like a good understanding with

the working force. To cure this, the night-school and the Y. M. C. A. must be supported and developed. Mr. Bruce speaks wisely, we think, on the subject of young college graduates undergoing the hard experience of manual labor in the mine with a view to qualifying as bosses. What he says needs no interpretation; nor does his sensible suggestion that our technicians should take a larger interest in civic and national affairs—in short, that they should realize their privileges as citizens. Undoubtedly Theodore Roosevelt ten years ago and Mr. Herbert Hoover today have quickened this impulse among the young men. Mr. Bruce himself, we happen to know, is a director of the Chamber of Commerce in his own city, so he appears to follow the advice he gives to others. That is characteristic; he is sincere. He is a man who does not waste words. Quiet and unassuming in manner, he suggests reserve power. As a young fellow he acquired unusual skill in surveying and mapping; that gave him his start; later he developed a keen sense of practical economics and thereby became a highly successful mine manager. He keeps closely in touch with everything that is going on; he is not a man of a dependent nature; he is progressive, and always on the lookout for any improvement in method or machinery; he is not prone to snap judgments, but looks before he leaps. The change from a big company like the Butte & Superior to a small affair like the Davis-Daly was a serious step for him to take, as he explains in the interview; he took it because he is enterprising and was willing to incur reasonable chances. That is the true spirit of mining adventure. He has shown self-restraint in adapting the equipment of the smaller mine to the exigencies of finance; in short, he is a manager, not a mere speculator. One who knows him well says he has a way of getting things done, and the ability to inspire co-operation. That he is loyal himself is suggested by his appreciation of loyalty in others. He realizes that to play a lone hand is a poor game; indeed, he is a born leader of men. He is still much too young to be looking backward; he has a future in which at least as much can be done as in the twenty years of his past active and responsible work. We wish him continued success.

DAVID W. BRUNTON

AN INTERVIEW

Mr. Brunton, you come of the old stock?

My parents came from Scotland; my father from Selkirk and my mother from Kilnmanock. My mother's people are now engaged in coal and fire-clay mining, but in the stormy days of the Reformation the Howies followed the blue and scarlet flag of the Covenanters, and the old Howie homestead at Lochgoin, which has been in continuous possession of the family for 700 years, is now used as a museum and repository of Covenanter relics.

Where and when were you born?

Ayr, Ontario, Canada, in 1849.

What was your early education?

Public school, followed by grammar school, after which I went to Toronto, in 1870, and began engineering work, as was the custom then, as an apprentice, under J. C. Bailey, the most prominent engineer in Canada and a member of the English Institution of Civil Engineers.

You came naturally to an engineering career?

Yes, most of my father's people have been either engineers or army men, some of them having made excellent records in England, India, and Australia. One of my cousins, recently deceased, J. Dickinson Brunton, was an inventor of stone-dressing machinery and of the tunneling machine, with which he made the preliminary borings for the proposed tunnel under the English Channel.

When did you come to the United States?

In 1873. In '74 and '75 I took an advanced course in geology and chemistry at the University of Michigan.

Had you any idea at that time of engaging in mining?

Yes, the studies just mentioned were undertaken because after four years experience in civil engineering I became convinced that at that time mining engineering offered a more attractive field.

Did you come directly west from the university?

Yes. The president of the Dakota & San Juan Mining Co. came to Ann Arbor in June 1875, and asked the faculty to recommend a young engineer to go with him to the company's mines in Colorado. They were kind enough to recommend me. I accepted the position and reached Denver on June 20. The company's mines were situated at Mineral Point, in Ouray county, and the nearest railroad station was Pueblo, 230 miles distant by a recently opened trail, over which all supplies had to be packed.

Did you remain at Mineral Point throughout the winter?

No, the Dakota & San Juan Mining Co. failed to get in sufficient supplies for the winter and we were obliged to come out before the passes were closed. I was fortunate enough to obtain a position as metallurgist for the Hunt, Douglas & Stewart Co. at Georgetown. This proved the beginning of a delightful friendship with James Douglas that lasted throughout his life.

Was the process applied successfully at Georgetown?

It was passing out of the experimental stage and I was fortunate enough to come in just as it was possible to bring the process into profitable operation. The result was that the company immediately began making money, a change that soon attracted the attention of the other mill-owners in the district.

Did you treat any large tonnage by means of this interesting old process?

According to the standards of the present day, the plant was small, having a capacity of 18 or 20 tons per diem. As soon as it was known that the plant was a success, H. Augustus Taylor, the owner of the Clear Creek works, offered me a much larger salary than I was getting, so, after giving the Hunt, Douglas & Stewart

people sufficient time to obtain a successor. I moved and built for Mr. Taylor the Clear Creek Reduction Works.

This was a custom plant, I suppose?

Yes, the Clear Creek works consisted of a Krom dry-concentrating mill, which, while somewhat difficult to operate, made an exceedingly clean lead-concentrate; but the middling, which consisted of pyrite and blende, carried a large amount of silver and was unsaleable. The mill that I erected was designed to treat this material, which it did very successfully.

By what method?

While at the Stewart mill I found that when the ore carried a high percentage of zinc and was given a chloridizing roast at a low temperture, chloride of zinc was formed, which acted as an excellent solvent of silver chloride, and in building the Clear Creek works they were designed to use the zinc in the ore and the resulting chloride as a solvent for the silver.

Please describe the process.

The middling from the concentrator was crushed to 60-mesh and roasted at a low temperature, thus producing the maximum amount of silver and zinc chloride, after which the red-hot ore from the furnace was run directly into an agitator, where the silver passed almost immediately into solution. Then the agitator was stopped, and the solid matter given sufficient time to settle, after which the clear liquor was drawn off with a siphon and run over copper plates, which gave us a beautiful crystalline precipitate of silver, the dissolved copper being recovered on scrap-iron.

That is very interesting. Did you remain long at Georgetown?

About a year and a half; then I went to Caribou, also in Colorado, to build a similar mill for the Native Silver Mining Co.

You used exactly the same process and also successfully?

Yes, and very successfully; but one winter at Caribou was enough for me. The mill was covered with snow for four months, so that nothing was visible but the ventilator and the smoke-stack,

and we had to tunnel through the snow from the assay and general offices to the mill.

So you sought a change, and whither did you go?

I had an offer to go to Silver Peak, Nevada, as engineer to build a similar mill to the ones at Caribou and Georgetown. After being there for about a year, the manager was taken ill and recommended that I be appointed his successor.

What company was that?

The Silver Peak Mines company, which was then controlled by John I. Blair of Blairstown, New Jersey.

What sort of an extraction did you get by the use of this leaching process and what was the approximate cost per ton, if you can recall it?

Comparing the assay-value of the ore with the amount in the tailing, the recovery would figure 95% to 97%, but, of course, that did not include the loss by volatilization during roasting, so that the net result was probably in the neighborhood of 93% to 94%. At Silver Peak the milling cost was unusually low owing to the fact that we had an enormous deposit of salt a stone's throw from the mill.

If you cannot recall the actual cost, and that isn't at all surprising considering how long ago it was, perhaps you can recall the average grade of the ore, which would show how rich it had to be in order to conduct operations at a profit.

The Silver Peak Mines company owned two groups of claims, one nine miles from the mill and carrying gold ore, the other four miles from the plant and carrying silver only. The new mill was built to treat the silver ores, which had an average yield of not far from 50 oz. per ton. The silver mines were soon exhausted, and after this we turned our attention to the gold mines, which had at one time been operated by Prof. Clayton.

What were his initials—J. E. Clayton?

Yes, Prof. Joshua E. Clayton.

He was a notable figure in mining in those days.

Yes. Further prospecting and development on the gold mines brought to light better ore than Prof. Clayton had been treating, with the result that the gold mines immediately became very profitable, the average recovery from the ore milled being about $12.50 per ton.

You were using stamp-milling and amalgamation?

We were using the old-fashioned stamp-mill with battery and copper-plate amalgamation, the same as was used by Clayton. John I. Blair, who was known as an exceedingly grasping multi-millionaire, became so excited over the profitable operation of the mines that he tried to buy out the minority stockholders. They, of course, under the circumstances, refused to sell, whereupon Mr. Blair told them that if they did not sell he would shut the mines and keep them shut-down as long as he lived, which was exactly what he did!

How long did the old rascal live?

For a long time, but I do not remember the date of his death.

Long enough to freeze them out?

No, he never succeeded in freezing them out, but his heirs sold the mines to the present Pittsburgh Silver Peak Mining Company.

Now we will return to you. When did you quit?

In September 1879, when Mr. Blair sent orders to me to close the mines down, pay all the bills, and put a competent watchman in charge. Just at this time the discoveries at Leadville were attracting the attention of everyone, and after fulfilling Blair's orders and seeing that everything was in shape for a permanent shut-down I went to Leadville, traveling by sled from Georgetown, arriving at Leadville early in the winter of 1879.

Leadville, I presume, at that time was booming?

It was indeed. At that time Leadville was the Mecca for adventurers of all kinds, and everything was crude; ore was being shipped as rapidly as transportation facilities would permit, or as fast as it was treated by small local smelters. In the

spring of 1880 a strike occurred, but it was of short duration. After that Leadville continued to grow with mushroom-like rapidity. One of the first things I noticed was that the surface ore, especially on Carbonate and Fryer hills, carried little or no lead and could be treated readily by what was known as the Washoe process, a method for extracting silver developed on the Comstock. F. M. Taylor and I built a mill in California gulch for treating this material, which we operated successfully for a number of years. After the operations of the mill were so stabilized as to require little metallurgical attention, I began engineering work for different companies in Leadville, the first of them being the Robert E. Lee, and subsequently for the Duncan, Wolftone, A. Y. & Minnie, and the Dinero. Later I was made manager of the Colonel Sellers mine, which at that time had the largest output of any mine in the district.

What was the character of that output?

The ores near the surface were argentiferous galena, but as depth was gained a considerable percentage of blende began to appear and soon the amount of it became so great that the zinc penalty imposed by the smelters materially interfered with our profits. After some study and experimenting, I designed and erected a mill to separate the galena and blende, which was completely successful.

What was the nature of your process?

Wet concentration by means of high-speed jigs and Frue vanners.

What sort of a product did you make?

The jigs made an excellent lead product with a very small tailing loss, but owing to the large amount of water flowing over them the vanners were not so successful. To remedy this, I designed a dewatering system by which we could put the pulp on the vanners at any degree of density we desired. This brought the recovery on the Frue vanners up nearly to that of the jigs.

Can you recall the percentages?

No, I can not. The A. Y. & Minnie mine was contiguous to the Colonel Sellers, and in mining they followed through much

the same cycle as the Sellers. As soon as Messrs. Graham and Guggenheim, who owned the A. Y. & Minnie, knew of the success of the process for separating blende and galena on the Colonel Sellers, they asked me to build a similar mill for them, which I was glad to do, and as the ores were identical the mill was a complete success.

If I recall correctly, the connection of Meyer Guggenheim with the A. Y. & Minnie was the foundation of the Guggenheim dynasty in the United States?

I believe so. At that time Benjamin Guggenheim was in the office of the A. Y. & Minnie and later he was persuaded by E. S. Holden to invest some of his father's money in a smelter at Denver. This was the first link in the chain of Guggenheim smelters, which now reaches across the United States, Mexico, and Chile.

So you had an interesting experience with the treatment of the complex silver-lead-zinc ores?

We had sense enough to know that the blende, which was not saleable then, would some day be valuable, and we built large log cribs on the side-hill, in which all of the blende, separated from the galena in both the Colonel Sellers and the A. Y. & Minnie ores, was stored. It was many years before this blende-concentrate became marketable, but ultimately it became valuable and was sold at remunerative prices to the Empire Zinc Company.

How long did you remain at Leadville?

Until 1886. At this time the mines in Aspen had come into prominence and the dispute between the different owners had culminated in a number of important apex-sideline lawsuits. As I had acted as engineer for the law firm of Patterson & Thomas in a number of mining suits, they asked me to go over to Aspen and assist them in their litigation. The suits were tried in the Federal Court at Denver, and after I had been on the witness stand all day I was asked to come to the attorney's office that night. When I entered the room in fear and trembling, expecting censure for sins of omission or commission on the stand, I found the sideline mine-owners of the district all there. D. R. C.

Brown, who acted as spokesman of the party, said, "We want you to come over to Aspen and take charge of our work". I replied that I had a comfortable home and a good position at Leadville, and did not want to move. The spokesman for the owners then said, "How much money do you want to sell out at Leadville and move to Aspen?" I mentioned a sum that I thought large enough to block proceedings, and the reply was, "You can't come too soon!"

So you agreed to sell out?

Their acceptance of my offer settled the matter, and as soon as I could arrange my own affairs and those of the Colonel Sellers I moved from Leadville to Aspen.

Were you married at this time?

Yes, I was married in 1885 to Miss Katharine Kemble of Kingston, New York, and at this time we were living very comfortably at Leadville and had one son.

So you moved to Aspen?

Yes. The apex-sideline suits involved mines on both sides of the Roaring Fork and for the first few years my work was confined to developing the mines for both economic and legal purposes, and handling the details of these suits. As soon as they were settled I was made manager of the Della S., the Free Silver, and the J. C. Johnson mines. On the Smuggler Mountain side of the district the difficulty of hauling the ore down the mountain and the depth from which water had to be raised made a more economical method of mining necessary, and the Cowenhoven adit was started and driven to afford cheap drainage, transportation, and ventilation for the mines of Smuggler Mountain and beyond.

What was the length and size of this adit?

The Cowenhoven adit had a length of two and a half miles, a width of 7 ft. 8 in., and a height of 7 ft. It was double-tracked throughout, and between the tracks was a covered waterway 12 in. deep and 16 in. wide.

Do you recall the cost of building this adit?

The cost of construction varied greatly according to the character of the rock through which the adit was being driven; it averaged about $20 per foot. At one point, for several hundred feet, we drove through soft porphyry, which crushed the timbers almost as fast as they could be put in place. At other points we ran through large open caves filled with dolomitic sand and broken rock necessitating the use of driven spiling. The weight on this spiling was so great that under the old-fashioned tail-block system of driving, the planks were battered and split before we could drive them into place, and I devised a new method of holding spiling in place, best described as a swinging false set.

Will you kindly describe it in more detail?

Under the old system the spiling was held in place by a block between the new plank that was being driven into place and the spiling on the last completed set. Under the new system no tail-block was used, but instead a light steel arched cap was pivoted over the sill last put into place and on this cap rested the forward end of the spiling that was being driven. The spiling was 3 by 6-in. plank cut to a chisel-edge. The false set carried the forward ends of the spiling and they were driven into the face, the forward movement of the false set being controlled by means of screw supports.*

Did you use square sets?

We did at first, but soon found that square sets would not stand the pressure and we were obliged to replace them by arched sets such as are used in railroad tunnels. In some places where the adit ran through crushed shale or softened porphyry the sills were pushed up so that we were obliged to replace them with inverted arches.

I suppose today, if you were to construct a similar adit in such yielding ground, you would use reinforced concrete?

Yes, provided that the probable life of the ore deposit were sufficient to justify the expense.

*A fully illustrated description is given in Proc. Inst. C. E., 1898, pp. 289-306.

You will recall, I expect, the early introduction of electricity in mining operations at Aspen. That must have some historic value.

I believe that electricity was first used underground in Aspen in 1888, when a 10-hp. electric hoist was placed in the Veteran tunnel by W. B. Devereux. When the ore deposits of Smuggler Mountain were found to extend well below the Cowenhoven adit, in order to sink inclines at distances of from one to two miles from the mouth of the tunnel, electric hoisting was the evident solution of the problem, and all of the mines operating below the adit were equipped with electric hoists. Later, when the inclines below the Cowenhoven adit attained considerable depth, it was considered advisable to sink a shaft from the surface not far from the mouth of the tunnel, and the Free Silver shaft was started. This shaft had a depth of 1200 ft. and its pumps have a capacity of 4000 gal. per minute. The electric hoist, which I designed for it, was for many years featured in the General Electric company's catalogues as the largest electric hoist in the world, but compared with some of the electric hoisting-plants now installed in this country and South Africa it was a very small affair.

Mr. Brunton, I know that you were connected in a professional capacity with important operations at Butte. When did that connection begin?

In 1890, while I was still connected with the mines at Aspen, Messrs. Patterson & Thomas were appointed attorneys for the Little Darling mine, which at that time was engaged in apex-sideline litigation with the Blue Bird mine near Butte, and they made the point to the Aspen mine-owners that the Little Darling was a sideline mine and that some points in that contest were so similar to those at Aspen that the legal decision in the Butte case might have an influence on the Aspen case, in view of which the Aspen owners consented to my going to Butte and taking engineering charge of the litigation.

Who owned the Darling mine?

James Murray, who was a great friend of Marcus Daly. This suit never came to trial because we forced the Blue Bird owners into an untenable position and they were obliged to buy the Little Darling.

Who was running the Blue Bird then? Was it William Keller?

No, Robert Boraem was manager and William Keller was engineer. After the transfer Mr. Daly, who had been following the progress of the suit with a good deal of interest, asked me to become consulting engineer for him, which I did, and remained with him until he sold the Anaconda mines to the Amalgamated Copper Company.

So you again became a participant in apex suits?

Yes, but at first the work consisted almost wholly of studies in economic geology, and as Daly was continually branching out and buying new properties, the amount of work involved was much greater than any one engineer could take care of. I mentioned this to Mr. Daly and he immediately said, "There's no strings on ye", which meant that I was free to make whatever arrangements I saw fit, and I then engaged Horace V. Winchell as geologist. The importance and value of the geological work carried on was so manifest that quite a staff of engineers and geologists was soon employed under Mr. Winchell's direction. At this time litigation was impending between the Daly and Clark interests in Butte, which later culminated in the Colusa-Parrot v. Anaconda suit.

This was the beginning, I presume, of the long series of litigations in Montana and also of the political warfare between the opposing factions?

Yes.

I would like to ask you to what extent the work done in connection with the litigation led to the discovery of orebodies, that is to say, to what extent it was economically valuable to the mining district.

It was of extraordinary value to the mining district, because it was during the progress of our studies that we gained the first inkling of the complicated fault-systems in Butte, the unraveling of which has enormously cheapened development and added greatly to the amount of recoverable ore. The economic value of this geological work was not at first well understood by the superintendents of the different mines, but later, in order to

utilize fully the work of the geologists, we devised a new system of mine-mapping that has been highly developed by the geological staff at the mines, so that today they have undoubtedly the best and most useful set of geological mine-maps in existence.

To whom would you give credit for the development of this interesting system of mine-mapping?

The beginnings of this system I devised at Aspen to enable us to follow and locate the faulted portions of the different veins. When we came to apply it to Butte this system had to be greatly elaborated and has been still further developed and improved by Mr. Winchell and his successor, Reno Sales.

What is the principle underlying this system?

The surveyors make the ordinary mine-map, from which the geologists take off individual level-sheets, copies of which they carry into the mine and record the geology on the sides of the openings exactly as exposed in the workings. Then, for the working-map in the office, we take a tracing on vellum of each individual level and place these sheets in what might be termed a large loose-leaf holder so that they occupy the exact position with relation to each other that they do in the mine. On each individual sheet there is platted not only the workings but the geology, and as you can read through about two or three sheets of vellum it is easy to see the relation of the workings, faults, and orebodies to each other. Under the old system the mine superintendents and foremen took but little interest in the geological maps, but as soon as the new system was introduced we found them spending a considerable portion of their time each day studying these maps and drawing inferences from them.

The use of this transparent vellum is comparable to the information obtainable from the model of a mine, by visualizing the relations between the workings and the discoveries of ore to each other, is it not?

Yes, but I think that maps of this kind are more convenient and useful than any model I have ever seen. The next step was for the mine superintendents, and even the foremen, to ask the geologists to go with them through the mines and discuss the exposures at each point where there was a difference of opinion,

so that in a short time after this system was put into use both superintendents and foremen were working in close harmony with the geologists.*

Now, Mr. Brunton, I want to put a delicate question. I would like your opinion as one better versed in mining litigation than any man, with the exception of Dr. Raymond if he were alive, as to the system whereby geological evidence is brought before the Court. I would like to ask you to look back upon your experience and to tell me, and tell our readers, whether you can suggest a better method of making the Court acquainted with the technical aspects of apex controversies.

The best method of placing actual mine conditions before a judge or jury is by some graphic method of visualization. Verbal descriptions of mine-workings convey little or nothing to a man who has never been underground. In some suits the attorneys deliberately challenge and reject from the jury a man who knows anything about mining, under the plea that he is probably already biased for or against the apex-sideline law, so that such juries are necessarily composed of men unacquainted with mining. As these men know nothing about mining law, and care less, they generally decide a suit in accordance with their sympathies, which are always with the side that they understand best; hence the necessity in a mining suit for introducing models, colored maps, and anything that will enable the jury to visualize conditions better than they can from verbal descriptions.

But most suits nowadays come before the Federal courts and are not tried before a jury, but before a judge. What I wanted to ask you particularly was whether the method of bringing evidence before the judge could not better be done by so-called experts or specialists not in the employ of the litigants but engaged by the Courts—even if secured by the Court under an agreement between the litigants?

I believe that such a method would be very much preferable to the present one, for the reason that it would then be possible to obtain unbiased testimony from the experts. While a witness is under oath he, of course, is obliged to describe conditions ex-

*A full description was published in Trans. A. I. M. E., July 1905.

actly as they occur, but his deductions from such observations are often biased by the opinion and attitude of his associates, and we all know that during the preparation of a lawsuit the men become enthused with their particular views; the mental attitude of one witness reacts on his fellows, and by the time the case is tried the experts are usually almost as partisan as the attorneys.

By the way, you have had some experience as an expert witness in British Columbia. Have they not a system there that is different from ours?

I have not taken part in any Canadian mining lawsuits, but, as engineer for the sub-contractor on the Canadian Pacific five-mile tunnel through the Selkirks at Rogers Pass, I was dragged into the litigation between my employers and the contractors. Many geological questions were involved in these suits and both sides freely availed themselves of the best geological talent in this country and in Canada, so that the testimony in many ways resembled that in an apex-sideline mining suit. During the trials I was particularly struck with the dignity and expedition with which these cases were conducted. Waste of time, through baiting of witnesses and wrangling between attorneys, was absolutely prohibited, and the judge had two assessors with him on the bench as advisors. These men were selected by the judge in chambers, were paid by the losing side, and the judge conferred and consulted with them on all technical questions arising during the trial. In both of these suits, the men selected to act as assessors were well qualified for the position, one of them being the most prominent civil engineer in the Province, and the other the largest railway contractor.

I remember you told us how you first became associated with Mr. Taylor. I know from my residence in the West that Taylor & Brunton is a firm that has been associated for several decades with the sampling of ores. Will you please tell us how you first got into this business and something about the technique of it, if the secrets of the business may be divulged at this late date?

When I was engineer for H. Augustus Taylor in 1876-'77, his son, my present partner, Frank M. Taylor, was acting as business agent for his father, and the old gentleman always insisted

that Frank and I should go into partnership. He said the combination would be an advantageous one for both of us, and talked so much about it that we finally followed his advice.

That was in what year?

That was in 1880.

How did you get into the sampling business?

Through testing sampling machines and methods for the smelters. In lead smelting it is more economical to obtain a correct smelting mixture by a judicious mixing of ore than by adding dead flux. If these ores are obtained by purchase from different owners it is important that their exact composition should be determined before mixing them on the bedding-floor, therefore, coincident with the growth of lead smelting in this country came the demand for more accurate sampling. The old-fashioned methods such as the divided chute, whistle-spout, split-shovel, riffle-board, and Cornish quartering, no longer sufficed, and a more speedy and exact method became almost a necessity. Various mechanical devices were invented for this purpose, and I was often called by the smelting companies to pass upon their accuracy, but always found them deficient in some important particular. This was hardly to be wondered at when we consider that the same machine must give accurate results whether the ore passing through it be rich or poor, wet or dry, coarse or fine. Later on, in thinking over the sampling problem, the idea occurred to me, why not make a division of time, which is something that can be divided with exactitude and to infinity. At first I was unable to tie this idea to any workable mechanical contrivance, but later succeeded in doing so, the result being the present oscillating time-sampler, which is acknowledged by everyone to give absolutely accurate results independent of the physical condition of the ore or the bias of the operator.

You are referring to the taking of the entire stream of ore for a fractional portion of the time?

Yes. I was fortunate enough to obtain a basic patent on the device for doing this, but other methods of obtaining the same result have since been devised, the most successful being the one invented by H. A. Vezin. Soon after the introduction of the

Vezin type of sampler, an ingenious but unscrupulous engineer, who unfortunately is still at large, devised a means of interfering with its accuracy. Vezin was a man of unusual ability and sterling honesty, and when he found that the device on which he had spent so much time and study could be tortured into giving an incorrect sample, it almost broke his heart.

What is the method?

The intake spout on the Vezin type of sampler is in the form of a sector, and unless its cutting edges are exactly radial the proportion of sample taken from all parts of the falling stream will not be equal, consequently it is only necessary to arrange the delivery spout so that the portion of the stream carrying the greatest proportion of coarse ore (which is usually the lowest grade) will fall through that part of the deformed sector which will take the largest proportion of sample. As the radial cutting edges on this type of sampler are of considerable length, their deformation by accident or design is extremely easy. A series of tests made at Cripple Creek shows that a slight displacement of the radial cutting edges with a conveniently arranged delivery spout would account for a difference of 10% in the sample.

Is it possible to interfere with the accuracy of the Brunton time-sampler in the same way?

No, the parallel cutting edges on the oscillator are so short and stiff that it is impossible to do anything that would interfere with the accuracy of the sample. We are so firmly convinced of this that we do not hesitate to allow men in our mills, who have interests in leases, to sample their own ore.*

Your name is also associated with the well-known pocket transit. What led you to invent this useful instrument?

When I first began the examining of mines an engineer was obliged to carry a small satchel full of instruments; I rebelled at carrying such a load and endeavored to devise a single instrument that would perform all the operations necessary in ordinary mine examinations and reconnaissance surveys. At first the re-

*For full illustrated description see 'Theory and Practice of Ore Sampling', Trans. A. I. M. E., 1895, and 'Modern Practice of Sampling', Trans. A. I. M. E., 1909. Also Bureau of Mines technical paper No. 86, on 'Sampling Conditions in the West', by T. R. Woodbridge.

sults were disappointing, but, by continued change and improvement, I succeeded finally in producing an instrument that was in every way satisfactory. At that time I had no thought of selling or patenting it, but simply had it made for my own personal convenience, but I soon found every time I went into a mine that the superintendent or manager would say, "Where did you get that instrument? I want one", and when I returned to Denver I would be obliged to order one, two, or three of these instruments for them. By and by the demand became so great that I patented it, in 1904, and made arrangements for its manufacture.

When did you manufacture your first instrument and who are manufacturing them now?

My first two or three instruments were made by Negretti & Zambra of London, in 1900 and 1901, but the length of time required to carry on correspondence about desired improvements and changes was so great that I finally arranged for the manufacture of the instrument with William Ainsworth & Son of Denver, who are still the sole manufacturers under all of my patents.

I understand that the instrument was used during the War.

The engineers who went into the Army naturally took their pocket-transits with them, and they proved so useful at the front that we had a steady flow of orders both from the Government and individual officers, and the military type of my instrument, which carries, in addition to the usual graduated circle, a radium dial for night-surveying and an alidade attachment for plane-table work, has been adopted now as standard equipment in the United States army. The military surveying instruments are all graduated from zero to 360° counter-clock so as to read azimuths directly from the north end of the needle, instead of being graduated from zero to 90° in quadrants as usually ordered by mining and civil engineers. There is much less opportunity for error in recording surveys by azimuths than by courses, and I would unhesitatingly recommend that all engineers adopt the military system. During the War, at the request of the military authorities, a slight variation of the standard pocket-compass was designed for use as a fire-control instrument for non-portable ma-

chine-guns. For this purpose the Government purchased 1500 of them. These instruments, of course, were graduated under the French mil system.

What is that?

Our system of dividing the circle into 360° means practically nothing, as we might just as well have divided the circle into 200° or 400°. A French military officer, some time before the War, conceived the idea of dividing the circle into 6400 parts, which he calls mils, the peculiarity of a mil being that it is approximately one-thousandth of the radius, consequently a deflection of one mil at 1000 metres distance would mean one metre; two mils, two metres, and so on, thereby enabling many problems relating to gun-pointing to be performed mentally and with ease and rapidity. In fact, this simple but brilliant invention has proven an important factor in the wonderful efficiency of French field-artillery.

When did you become interested in Cripple Creek?

I went to Cripple Creek in 1894, but we did not build our first sampling-mill there until 1896, the second and larger plant being built in 1901. Later, when the mines of Cripple Creek became so deep that the expense of individual pumping became prohibitive and some central system of drainage became necessary, the Mine-Owners Association asked me to study the problem and decide on a method to be employed. Topographic surveys of the district and a study of the amount of water coming into the different mines showed that the most economical method of drainage would be by driving a drainage adit, and my recommendations were made accordingly.

What was this adit called and what is its length and the amount of water tapped?

This drainage adit was promptly christened the Roosevelt Tunnel, by which name it is generally known. Its length from the portal to the principal watercourse in the ore-zone is 17,200 ft. The amount of water flowing from the tunnel when this watercourse was first tapped was 12,000 gal. per minute, which has gradually diminished until today the flow is less than 1000 per minute. The contractors for this tunnel elected to use

the old Leyner rock-drill, and later Mr. Leyner sent to them a new small pneumatic water-feed hammer-drill for straightening out the sides of the bore and removing inequalities from the floor. To the astonishment of everyone, this little hammer-drill did faster work than the big piston-drills, and it was clear that a new mining tool had been developed which marked a great forward stride in rock-drilling machinery. It took some time for me to persuade my old friend William L. Saunders, president of the Ingersoll-Rand company, that a new drill had been invented which promised to revolutionize the rock-drill industry, but at last he came out to Denver and after an examination of the Leyner hammer-drill did not rest until he had purchased all of Mr. Leyner's patents and engaged him as consulting engineer for a five-year period. The Ingersoll-Rand company immediately used their vast resources to improve and perfect this drill until today machines are being produced under this system that will drill 12 inches per minute in hard granite.

Cripple Creek is quiet now, is it not?

Cripple Creek, of course, is not as lively now as it was in 1900, when it had a yearly output of $18,000,000, but a district which has produced $315,000,000 in 29 years and is still producing at the rate of $5,000,000 per annum is very far from being defunct.

Did you take part in apex litigation in Cripple Creek?

Yes, as consulting engineer for the Golden Cycle company, during their litigation with the Vindicator. This suit, however, never came to trial, as it was settled by a consolidation of the two companies. One of the models built for this suit, however, is worthy of mention. It became probable that an important factor in the case would be the showing in the discovery shaft of the Golden Cycle mine. Just how to present the facts shown in that opening to the jury puzzled me for some time, but I finally hit upon a plan that proved eminently successful. The Natural History museum in Denver had brought out an expert from New York to make rocky backgrounds for the different animal groups in the museum; these were so beautifully done that anyone interested in geology could not help noticing them. Just at the time this expert had completed his work and was about to return

to New York, it occurred to me to ask him if he could not reproduce the discovery shaft of the Golden Cycle, to which he agreed, and in two months made a model that was an absolute reproduction of the discovery shaft in form, texture, and color. I think this method of showing conditions can be used successfully in many cases. The gentlemen on the opposite side of the case, when once the suit was settled, were quick to acknowledge that this reproduction of the shaft would have meant their certain defeat had the case come into court.

Are your sons mining engineers?

Only one of my sons elected to study mining engineering, and, on the completion of his sophomore year at the Colorado School of Mines, he went on a surveying trip during the summer to North Park, where he became enthused over pure-bred stock-raising and absolutely refused to go back to college. There was nothing to do but to let him follow his bent, in which I was much disappointed; but perhaps it is all for the best, as Jack is now owner of the Glendale stock-farm and has made a greater success in raising pure-bred polled Herefords than he was likely to do in mining engineering. My oldest son, Fred, was graduated as metallurgical engineer from McGill University and is now in Mexico. My youngest son, Harold, graduated with honors as mechanical engineer at the University of Colorado, and is engineer for the Plains Iron Works of Denver. My son-in-law, G. B. Shanklin, is an electrical engineer engaged in research work for the General Electric Company.

How do you compare the facilities for education in your day with those that your sons have been able to obtain?

The engineering colleges of today are so far ahead of their predecessors of forty-five years ago in personnel, apparatus, and equipment that present-day students have opportunities both in college and after leaving it that we old-timers never dreamed of. When I came West, mining engineers were scarce, and, worse than that, American mining engineers were not considered to be in the same class with the German. It took many years to convince the general public that the American engineers were better qualified to handle conditions in the West than foreigners.

I understand that you have made a number of trips to Spain.

How were you impressed with Spanish mines and miners?

Spain is a country of wonderful mineral resources, and although many of the mines have been worked since prehistoric times, they are still far from being exhausted. Some of the largest producing mines of today were worked by the Phoenicians and furnished copper for the bronze that went into Solomon's temple, and have since been worked successively by Roman, Moorish, Spanish, and English owners. In early times, before the days of explosives, mining operations were necessarily slow and mines had some chance of longevity, but in recent years many of the oldest Spanish mines have been subjected to the most intensive attacks with modern air-drills and steam-shovels without seriously decreasing their reserves. Contrary to what I was led to expect from my experiences in Mexico and South America, I found the Spanish miner to be an exceedingly cleanly, skilful, and industrious individual. Of course, he has some racial characteristics, and dislikes being bossed. Out of this, and some other traits, has grown the curious and far from inconvenient system of working now in vogue at many of the mines. Guided by the unions and local custom, there has been established in each district what constitutes a standard day's work in all surface and underground occupations, and when this amount of work is performed the men receive from their foreman a ticket that they cash at the paymaster's window on their way home. This plan gives them an unusual degree of personal freedom, as it allows them to begin work when they choose and they are free to quit whenever the day's stint is accomplished. Under this system most of the men begin work about 6 a. m., and by 1 p. m. the more energetic and skilful have completed their tasks and begin moving homeward. By 4 p. m. the mines are practically emptied.

In what particular work were you engaged while in Spain?

Consultation work for the Rio Tinto company. They especially wanted me to study and devise some means of recovering the enormous tonnage of ore left behind in the floors and pillars of one of their largest mines after it had been worked to the limit by the pillar-and-stall method. The immense size and great depth of this deposit, coupled with the property of self-ignition

when large masses were allowed to move or slide, precluded all possibility of using any of the established systems of mining. After a great amount of study, consultation, and experiment, a method was finally devised that has proven safe, economical, and completely successful in recovering all of the ore from these old workings.

Will you describe the system briefly?

It is a direct replacement system, taking full advantage of both surface and underground conditions as well as the habits and skill of the Spanish miners, but an intelligible description would require drawings that would be scarcely worth while, as I do not believe that such a complicated and exacting system could be successfully employed anywhere else on earth.

You did all that you could during the War, I am sure. In what particular service were you engaged?

When the United States entered the War, the different scientific and technical societies in this country held a series of meetings to decide what they could do to assist the Government, the result of which was that each society elected two members to represent them on a central body to be known as the War Committee of Technical Societies. Edmund B. Kirby and I were chosen to represent the American Institute of Mining Engineers, and H. W. Buck of New York was elected chairman of this committee. Shortly afterward pressure of work entailed by some large Government contracts, which his firm had received, compelled Mr. Buck's resignation. I was elected his sucessor and served in that capacity throughout the War. The War Committee soon found that with the various societies behind them they had an abundance of scientific and technical assistance but were grievously short of funds. The Naval Consulting Board, which had been created for some time, was in exactly the opposite position. Its members were all prominent busy men, many of them engaged in Government work, and they had little time to devote to the incoming flood of war inventions submitted to the Government, and after several consultations the War Committee of Technical Societies decided to co-operate with the Naval Consulting Board. This gave us offices, money, clerical and stenographic help, Government printing facilities, and a

postal frank, by means of which we were able to accomplish much more than our original program contemplated. Later, I was appointed by Secretary Daniels a member of the Naval Consulting Board, and about the same time I was made a member of the Inventions Section, Plans Division, of the General Staff of the Army.

That was fine.

The work assigned to the Naval Consulting Board, Inventions Section of the Army, and the War Committee of Technical Societies was the consideration of inventions submitted to the Government for use in the War. The great interest that the inventors and scientific men of the country took in the contest soon brought such an avalanche of ideas and inventions that our New York office had to be enlarged, and later, the Government asked that we move our headquarters to Washington, where we were given ample room and every facility for work. Something like 135,000 ideas, suggestions, and inventions were submitted. The bulk of these, of course, were useless, but it took a vast amount of work and study to separate the few grains of wheat from the mass of chaff. Even among the meritorious inventions received, few were sufficiently perfected for immediate utilization, and a great amount of time and effort were required to develop and test them preparatory to manufacture. The French and English also had their Inventions Boards, which were in existence, of course, much longer than ours, and they also found that to develop, test, and put a new invention into quantitative production required not far from a year.

Were any of the suggestions or inventions put to fruitful use during the War?

Yes, some of them were; and had the War continued six months or a year longer some very important inventions would have come into general use at the front that would have done much toward convincing the Germans that General Sherman's description of war was correct. One of the most important results of the activities of the Naval Consulting Board has been the adoption of a plan for building a large experimental machine-shop and research laboratory for the Navy, on the banks of the Potomac, a few miles below Washington. For this purpose

$2,000,000 has been appropriated, government land set apart on which to build, and contracts let for the entire plant. This experimental shop and laboratory will be used not only for research work of all kinds connected with the Navy, but new inventions submitted from any source for naval use will be examined and tested, and those which are found to possess sufficient merit will be developed, perfected, and carried forward to a point where they will be put into immediate use or held ready for quantity production in case this country should at any time be unfortunate enough to be forced into another war.

AN ALL-ROUND ENGINEER

*At the last meeting of the American Mining Congress, at Denver, in November, a certificate of honorary life-membership was handed to Mr. David W. Brunton, and the incident evoked hearty applause. It served not only as an appreciation of his services as a director of that organization of mining men, but it marked the high esteem in which he is held in the mining fraternity. Shortly afterward we took an opportunity to interview him, and the result appears elsewhere in this issue. Mr. Brunton belongs to a group of Canadian-born Americans who have played a conspicuously useful part in our national mining industry. To that group belong Richard P. Rothwell and James Douglas among the honored dead; to it belong E. P. Mathewson and W. J. Hamilton among the honored living. Our young men, curious to ascertain the steps by which their seniors achieved success, will note that Mr. Brunton was fortunate, first, in coming of engineering stock, and, second, in being educated at the University of Michigan. A touch of romance, that is, of the delightfully fortuitous, was given to Mr. Brunton's start in life by the visit of a gentleman from Colorado to the university at Ann Arbor. This stranger from the Rocky Mountains was the president of a mining company in search of a young engineer to take charge of a small property in the picturesque San Juan region. This first call to the mines proved abortive in its economic results, but it led to a new engagement, and to a critical

*Editorial in the 'Mining and Scientific Press' of May 28, 1921.

event in Mr. Brunton's life, namely, an acquaintance with James Douglas. To know men is more than to know mines; the friendship that developed with Douglas was one of the good things of life. And many are the men who have been able to say that about James Douglas! It seems like the turning of old pages to read about the Hunt & Douglas process at Georgetown and then to find a mention of Joshua E. Clayton. Those early adventures in Colorado and Nevada did not seem to lead anywhere in particular, but they gave the young Brunton of those days a variety of experience, developing his character and opening his scientific eyes to the basic principles of the mining industry, so that he was ready for the big opportunity when it came, in 1879, at Leadville. There he became associated with his life-long partner, Mr. Frank M. Taylor; together they built the first reduction plant at Leadville; and, later, erected and controlled several sampling-mills in Colorado, Utah, Nevada, and Montana. This phase of ore-dressing became a specialty to Mr. Brunton, it proved highly profitable to him, and it gave him an opportunity for the exercise of his ingenuity in mechanics, for he invented a contrivance that has become standardized in the sampling of ores. Here we may refer to the other device that carries his name, the compass familiar to mining engineers. During the War this Brunton compass proved invaluable, many thousands having been used advantageously on the battlefields of France.

As has been suggested, the Leadville adventure proved a decisive event in Mr. Brunton's early career. It gave him an opportunity to study the concentrating and sampling of complex ores; moreover, it gave him a chance to examine the ore deposits of a district marked by a remarkable intricacy of geologic structure, and to appreciate the structural relations of orebodies, particulary with regard to faulting and brecciation. In due course he was asked to participate in the litigation that almost submerged the mining industry of Aspen; he became an 'expert', in a series of important apex suits, that is, he was a witness in court. But he did more: for he directed the work done underground that served to uncover the evidence needed by the lawyers. This, of course, gave him an unusual opportunity for becoming familiar with the local geology and for developing his own general knowledge of economic geology. He still continued his engineering work; he supervised the driving of the Cowenhoven adit and the

sinking of several deep shafts. His reputation at Aspen led to his being called to Butte, where apex litigation on an even bigger scale had been started. There he devised new systems of mine-mapping, and, as consulting engineer to the Anaconda company, planned the exploratory work underground that resulted in the uncovering of large masses of ore. We asked Mr. Brunton, it will be noted, what he thinks of the present system of bringing evidence into Court; he states, as we thought he would, that unbiased testimony is difficult to obtain from witnesses engaged by the litigants themselves and therefore already committed to one side in the dispute. As an example of a better method, he quotes an experience of his own in a Canadian court. In later years Mr. Brunton has lived in Denver, partly on account of his interests in the neighboring mining districts, notably, Cripple Creek, where he served as the engineer in charge of the Roosevelt adit, in the driving of which a pneumatic water-fed hammer-drill, invented by the late George Leyner, a Denver man, first came into prominence. From Denver Mr. Brunton has been called in an advisory capacity to distant places, among them Spain, whither he went in 1903 to advise the Rio Tinto management in regard to the recovery of ore left in their old workings. He has traveled all over the world, and around it. During the War, of course, he did his share of patriotic work, and it proved to be important. As a member of the Naval Consulting Board he tells us, as others have done, that if the War had lasted a little longer the world would have been astounded at the deadly inventions and lethal devices that would have been brought into action. Another general war is unthinkable for that reason, if for no better one.

The mere record of a man's achievements does not tell the story of his career, for a man can do many things worthy of being chronicled and yet leave no enduring footprints. The best memorial is the one that is transmitted by the living. In the first place, Mr. Brunton has been accepted as a leader among men, having been president of the American Institute of Mining Engineers in 1909-1910. To this mark of distinction we venture to add the statement that in accomplishment and reputation he stands second to no mining engineer in the English-speaking world. He is one of the few mining engineers that have kept away from speculation, promotion, and the other dangerous, if

not shady, sides of the mining business; he has preferred to stick to engineering work, rather than make money quickly in devious ways; for that reason his standing is unquestioned and for the same reason he has enjoyed a mental poise highly conducive to real scientific work. He has the ability to concentrate his mental faculties on the problem in hand. By the same token he prefers a few friends to common popularity; he sticks to a friend and does not forget an enemy; he is a man of positive character, not a Laodicean. He is a man of progressive and independent ideas; he was one of the first to drive an automobile in Colorado; he has experimented with a score of them since, and was nearly killed in a motor-accident eleven years ago. A friend who has motored thousands of miles with Mr. Brunton says that he is impatient of stupidities or dishonesties of any kind, but is generous to a fault. Like all true students, he is avid for information. On board ship, having seen a friend in conversation with a newly made acquaintance he asked, "Does he know anything?" He remembers his fellow-workers even after many years. When in a club at Waihi, New Zealand, he heard the name of Stansfield mentioned as the manager of the Talisman mine. He recalled the fact that Mr. Harry Stansfield had worked for him in Nevada twenty years earlier and promptly got in touch with him by telephone, this resulting in a visit to the Talisman. One of his oldest friends, who has voyaged afar with him, summarizes his impressions thus: "He is a man of particularly strong likes and dislikes; absolutely true to his convictions; loyal to a degree in his friendships; of exceptional determination in his undertakings and possessed of a deep insight into human nature as well as things material". We confirm that, and to it we add that he is blessed with a sense of humor that lightens the dark places and a geniality that thaws the frozen currents of life. Yes, a man every inch of him, an excellent engineer, and a good citizen. The mining profession is proud of him.

the Bullion Beck & Champion mine, to do their underground surveying and make myself generally useful as an outside foreman when there was not enough to keep me busy with the surveying. I stayed there until the latter part of 1891.

What pay did you get?

I got $180 per month, with my room and board. In the middle of 1890 I gave up all the work at the mine except the surveying and the construction of a waterworks system, and took a commission as U. S. Deputy Mineral Surveyor, which proved more profitable. I was married on January 1, 1891, and within a few months it became evident that my wife could not stand the altitude, so I resigned from the Bullion Beck & Champion, and moved to Salt Lake, where I opened an office as Mineral Surveyor late in 1891, but I continued to make periodical trips to the mine for the purpose of keeping up their surveys. On the first day of January 1893, I was offered the superintendency of the mine and remained in charge until about April 1894, when the property changed hands and I was fired.

What was the reason?

The mine passed into the control of others. There had been a bitter fight for the control of the mine and I was believed to be a partisan of those who had formerly controlled it.

Did you return to Salt Lake?

Yes, and re-opened my office there as Deputy Mineral Surveyor. I also took a lease on the Northern Spy mine, in the Tintic district, which I operated under a lease for a year. This proved to be about the first easy money I ever made. During that year I became interested in the local geology and conceived the idea that a block of ground lying between the old Mammoth mine and the Centennial Eureka ought to contain a considerable quantity of ore. I interested C. E. Loose in the matter of developing it and secured options on the property. Loose carried the enterprise alone for about six months and then incorporated the Grand Central Mining Co. The Grand Central was financed by Loose, the present Senator Smoot, an Ogden lawyer named David Evans, and a hotel proprietor of Provo named Lafayette Holbrook.

How did it pan out?

It proved successful, though nearly all of the original money subscribed, $125,000, was expended before any ore was found. It finally became a profitable mine and it has paid about $1,500,000 in dividends and is still paying dividends. It suffered greatly on account of apex litigation with the Mammoth.

So you had your first taste of apex litigation, Mr. Burch?

I was personally touched by it because the shares which I had valued at $9 declined within a year to about $4, at which price I sold my holdings in the Grand Central, after removing to Wardner, Idaho.

When did you go to Wardner?

In the spring of 1897, but before going there I acted for a few months as substitute manager of a little gold mine in the western part of Oregon. It was owned by an English company —Lawler's Gold Mines, Ltd.—and Mr. Lawler was the manager. He went to Europe in the fall of 1896 for treatment of his eyes and I took his place during his absence. It was while I was manager of this little concern that I first met F. W. Bradley, in February 1897. He came to make an examination of the Lawler mine for some of the shareholders whom he had just met in London. At the conclusion of the examination, he suggested that in case I should want to leave the Lawler mine, he would be in position to offer me the superintendency of the Bunker Hill & Sullivan. He evidently knew that when his report reached London the Lawler mine would no longer be operated, and in the course of two or three months this developed. I went to Wardner as superintendent of the Bunker Hill & Sullivan on the first of May 1897.

Then, you were in charge of the mine at the time of the destruction of the mill at Kellogg?

Yes, I was; and saw the mill blown up.

Looking back, what is your opinion as to the merits of the industrial quarrel in the Coeur d'Alene at that time?

I think that the wages which were being paid by the Bunker Hill & Sullivan just prior to the strike were perhaps too low considering the era of general prosperity that was then beginning.

ALBERT BURCH

AN INTERVIEW

You were born in the West, Mr. Burch?

I was born at Peru, Nebraska, on January 8, 1867.

What was your father's occupation?

Methodist minister.

How did you get your taste for mining?

Through surveying underground. There was no mining in our part of the country. The first mine I saw was the Homestake, in South Dakota, when I was a boy on a railroad survey in 1882.

What was your education?

The equivalent of a high-school training at the State Normal School of Nebraska, followed by one year, when I was 16, in York College in the town of York, also in Nebraska.

What was your first job?

As a boy I worked during the summer on gardens and farms for a few cents per day. My first important job was with the Burlington railroad, in 1880, when on Friday afternoons and Saturdays I made computations on earthwork quantities. The next summer I commenced work for the same people in the field, beginning as back flagman and advancing to chief of a locating party. I remained with them until 1888, when the locomotive engineers' strike caused them to cease construction of new lines.

How long were you engaged in railroad work?

Until May 1889.

What led you to your first engagement in mining?

While I was in charge of construction of a branch railroad tc the mining camp of Eureka, in the Tintic district, Utah, I was asked by Hank Smith, who was at that time superintendent of

or four months; in the meantime the revolution in Mexico commenced, with the results that the Chicago Exploration Co., which was largely interested down there, decided not to take up new enterprises. This left the Plymouth option on my hands. I tried to interest various parties during the summer of 1911, but was not successful until I met W. J. Loring of Bewick, Moreing & Co. He came to the United States on a visit to his mother. Through his firm, British capital was interested in the development of the Plymouth by means of a corporation called the California Exploration Co. The development period extended from late in 1911 until early in 1914, when the Plymouth Consolidated Gold Mines, Limited, was organized, the control of the shares being taken by the California Exploration Co., the remaining shares going to Mrs. Lane, Mr. Hall, and myself. Since then the mine has been operated continuously and has practically returned its entire cost, namely, $1,000,000, and still has good prospects.

While you were consulting engineer of the Plymouth, you built a club-house at the mine and did other things to promote loyalty among the men. What are your views on welfare-work?

Under the head of what is called 'welfare work' a great many things are done that do not really help to promote good feeling between the management and its employees, because there is frequently a lack of genuine sincerity in the conduct of the work. My own belief is that welfare work, so called, is only useful when the head of an enterprise takes a genuine interest in his employees. A man, or a crowd of men, will quickly detect the lack of sincerity, if it is lacking; and that affects anything that can be done to promote cordial relations. Human sympathy must exist between the management and the men, for without it no amount of money expended for club-houses, entertainments, housing, and sanitation can be of real value in promoting cordial relations. It becomes an empty shell without the kernel of genuine feeling.

With what companies have you been connected in later years?

In 1911 I was consulting engineer to the Goldfield Consolidated Mines Co., at Goldfield, Nevada, and during the years 1913-

1914 I was general manager for the same company.

You must have had experience with ore-stealing, and taken measures to prevent it?

No, I did not. That was before my time. We had difficulty in finding ore rich enough to return a profit after it was handled in the mill, rather than through a custom assay-office.

What would you regard as the most pleasant feature of your management of this mine?

Aiding in the building up of a more cordial feeling between the business-men and townspeople of Goldfield and the management of the mine. It commenced with a dinner to which about 250 people of the town and the more important mine employees were invited. On this occasion a club for better social intercourse between all classes of the community was launched. It aided greatly in establishing more cordial relations between the people of the town and the company. There had been a spirit of suspicion between them, although there was really no reason for it. This reminds me that long before, when I was at Wardner after the strike of 1899, a local union was organized largely on the initiative of Mr. Bradley, and it served as a pattern which I was able to follow in later years at Goldfield and Plymouth. There is no question but that a man's success in life depends largely upon his standing in the community in which he lives and in which he does business, and the same applies to a corporation. Unless the corporation has the good-will of the people in the local community, it will always be subjected to all kinds of annoying and frequently expensive impositions. Whenever there is a spirit of distrust, you have a condition of constant bickering and attempts at gouging, all of which cost real money to the corporation; therefore, either from a standpoint of comfort in living or in actual profits, the corporation can well afford to spend some thought and some money upon maintaining cordial relations between itself and the people in the community in which it operates. It is largely the spirit of the people of Kellogg and Wardner that has maintained industrial peace at the Bunker Hill mine for the last tweenty years.

Why did you leave Goldfield?

I was tempted and fell. Mr. Jackling persuaded me to go to Butte in the interests of the Butte & Superior Co., in connection with its litigation with the Elm Orlu. This made it impossible for me to continue my duties at Goldfield.

When did you become consulting engineer for the Mountain Copper Co.?

In 1913. Our firm of Burch, Caetani & Hershey became consulting engineers to the Mountain Copper Co. in 1913. Gelasio Caetani was in London early in 1913 and met yourself and through your introduction to then Captain, now Major, Lawson, who was the chairman of the board of directors of the Mountain Copper Co., a connection was established with them in that year. Mr. Caetani, as you know, is an Italian mining engineer, who has specialized in concentration. For instance, he re-designed the Bunker Hill & Sullivan concentrator at Kellogg, Idaho, and designed the mill of the Mountain Copper Co. at Keswick, re-constructed the mill for the Tomboy Gold Mining Co. in Colorado, designed a plant and mill for the Plymouth Consolidated of California, and has acted in a consulting capacity for many concerns interested in the concentration of ores. At the beginning of the World War he returned to Italy and became an officer of engineers in the Italian army. He little expected at that time that he would remain in Italy, but owing to the death of his father and other changes which were brought about by the long-continued war, he finally decided not to return to the United States. Thereby a very valuable man is lost to the profession of mining engineering. The firm of Burch, Caetani & Hershey was organized on the first of January 1912, the third member of the firm being O. H. Hershey, the well-known geologist for the Bunker Hill & Sullivan and other concerns. Since the decision of Mr. Caetani not to return, his place in the firm has been taken by Lloyd C. White.

Looking back, Mr. Burch, over your thirty years of experience, what are the chief changes in mining operations and in the men by whom they are performed?

The introduction of much lighter and more readily adaptable machine-drills is probably the thing that has aided most in bringing down the cost of actual mining operations and also contributed largely to the comfort of the men themselves. The develop-

ment of electric power and its transmission to all parts of mine-workings has also aided greatly in reduction of cost and in addition to comfort. A study of ventilation in many mines has aided materially. So far as the miners themselves are concerned, I look back to those whom I knew first as a sturdy race of Cornishmen and Irishmen. They have practically disappeared from the larger mining districts, though they and their children, and grandchildren, are found in some of the smaller and older districts of the country, such, for instance, as Grass Valley in California and Central City in Colorado. The miners who succeeded them in the regions with which I was familiar were largely Swedes and Finns. There are still a great many Finns employed in sections of the country, but very few Swedes. Most of the miners now are from south-eastern Europe, and, in my opinion, do not measure up to the standard and type of men that I knew at the mines in my younger days.

To what extent are steps being taken to promote Americanization, and to what extent do you think such steps can be taken successfully?

I am not familiar with the work which is being done by the various Americanization organizations, nor am I in close touch at present with any large operations where individual companies are attempting to carry on a campaign of Americanization. I have no doubt that systematic work of this kind will attain favorable results if sufficiently persistent. I believe that the more we can educate and imbue the foreign element with American ideas and American ways the better it will be for the future of mining, as well as for the country. I also believe that the training of native-born Americans in mining is one of the things that will have to be done in the next few years.

Have you done anything in the way of night-schools?

I have not. I tried to get some companies interested in private night-school training for the younger employees of the mines. The idea did not meet with a favorable reception, and nothing was accomplished.

You have participated in a good many mining litigations?

Not very many. About half a dozen, but they all happened to be important cases.

May I ask you whether you have any opinion as to the present method of eliciting facts before the Court, and whether you can suggest any better method?

I certainly think that the present method is wrong, because it develops partisanship upon the part of the men who should be studying questions from a strictly scientific standpoint and because of the great waste of money which the method entails upon the litigants. It is a waste of energy and a waste of money that might be avoided by the development of special courts for the trying of mining suits. This is not an original suggestion. It is one that I obtained from Judge Farrington of the U. S. District Court of Nevada after the long drawn-out trial of an extra-lateral suit in the court in 1912. He expressed the thought well when he said: "Here I have listened for three months to eminent scientists taking absolutely opposing views upon scientific questions and I as a judge not trained in geology am called upon to decide which group is right". He added: "This is a farce and could be cured by the establishment of specially trained courts for the disposal of such litigation".

Therefore, you would not approve the retention of the present courts with provision that the expert witnesses be engaged by the Court itself?

No, for the obvious reason that the Court would still be left very much in the dark as to the facts because of lack of training in matters of geology. I do not know whether it would be possible under our system of government to require that cases of this kind be submitted to Boards of Arbitration instead of the present courts, but if this can be done, I would suggest a Board of Arbi-

You were engaged in stimulating the production of minerals during the War, for the Government, were you not?

I regret to say that I was. I thought it was my patriotic duty to do what I could toward advancing the interests of the nation in connection with the War and did not feel that I could probably be of much service in the Army, and therefore did not attempt to enter the Army, but early in the War made application to Government bureaus for employment in a volunteer capacity. I was accepted as a consulting engineer for the Bureau of Mines and was first sent to Cuba to investigate the manganese and chrome resources of that island. Later, I was placed in charge of the district embracing Oregon, California, and other Western States, with a selected field force for the purpose of examining and reporting upon chrome mines in the territory and advising the operators of the mines to the end that production might be made as rapid as possible. This work occupied practically all my time from the beginning of May 1918 until after the signing of the Armistice. It then became evident that the industry had been over-stimulated. I have deep sympathy for those who were urged by the various government agencies to begin the production of war minerals as a patriotic duty; but have no sympathy for those who have used this as a cloak to cover exorbitant demands for the reimbursement of funds that were never lost at all.

Do you consider that the decision of the Secretary of the Interior, acting on the advice of the Attorney General, that only the personal solicitations of the Government bureaus should count as proof of work done in response to the Government was unfair? Do you not think, with me, that the relief given should include all those who responded to the request of the Government as advertised in the press, daily and technical, of the day?

Certainly I agree with you, because a direct personal request was made of comparatively few people and usually the larger and more important operators. The small producer was not approached directly, and yet frequently it is the small producer who has to stand the largest percentage of loss.

How do you regard the question of unionization of mine labor? In other words, is it feasible or practicable to maintain the open shop?

I am a strong believer in the local union, which affords machinery for collective bargaining, the handling of grievances, and a closer approach between the management and its employees, without the danger of sympathetic strikes, which are brought on through causes in which the local people can have no interest or knowledge whatever. I do not believe in the salaried business agent, or 'walking delegate', as he was formerly called, who feels that he must stir up trouble and cause turmoil in order to hold his job. I think perhaps if his relationship to the union would change to something like that of the Chinese doctor who is paid a regular fee as long as he keeps his patient well and none while the patient is sick, it might make a great difference in the handling of labor questions between the business agent of the union and the manager of the property.

And you undoubtedly wish the manager of the mine likewise to play the part of the Chinese doctor?

He does now, for he is paid his salary as long as he makes good; when he cannot, he loses his job.

To what extent do you approve of the more modern practice of employing graduates as shift-bosses in mines?

My experience in that has been a little unfortunate. I have employed college graduates as shift-bosses in mines with rather poor success unless the college graduate before, as well as after, entering upon his college career had had a considerable mining practice.

You mean as a working miner?

Yes. The graduate of a mining school who comes from a mining district, was born and reared in a mining district, can usually be depended upon to make a good shift-boss if he has the other necessary qualifications, including physique, but the graduate of a mining school, who is reared in the city, or even in the country districts, where he did not absorb the mining atmosphere, does not as a rule make a good mining man in comparatively subordinate positions. What do you think about it?

Well, Mr. Burch, I think this, that comparatively few young men have the physique as well as the intelligence to do the hard work of the miner preparatory to becoming shift-bosses, and I believe thoroughly that the sort of leader of men that the shift-boss must be is only developed by actual experience in the manual labor that his men are performing. Would you have made a good shift-boss?

I would not, because I had not the practical experience that goes with the duties of a shift-boss, or that leads up to a knowledge of the duties of a shift-boss.

Whereas your experience in surveying and in railroad work did prepare you to become the superintendent of a mine?

It helped.

You have taken a keen interest in the California Metal Producers Association?

Yes, after observing for two years the operation of the Nevada Mine Operators Association, which I assisted to organize, I thought I saw the need for something along similar lines in California. Therefore in 1914 I invited some eight or ten prominent mine operators in California to lunch with me at the Engineers Club, San Francisco, where, after a few hours discussion we commenced the organization of the California Metal Producers Association. This, I believe, has been of value to the mine operators in California. It is now affiliated with the American Mining Congress and embraces within its membership nearly all the large mines and many of the small ones in the State.

What work does it do more particularly?

The first and most important work that it did was to bring about a spirit of harmony between the mine operators and the newly organized California Industrial Accident Commission; it aided in formulating the rules that were promulgated by that Commission in connection with the operation of mines; it supported the Commission in its efforts to reduce rates for workmen's compensation insurance, thereby saving to the operators considerable sums of money. It has maintained an inspection service for the mines of the State for the last three or four years, the Inspector of the Association having at all times harmonious rela-

tions with the inspectors of the California Industrial Accident Commission, and in legislative matters it has been of considerable aid to the mining industry in combating vicious measures. These are among the principal things accomplished by the Association, though a great deal of attention has been given to First Aid work and the general improvement of operating conditions about the mines.

You and I, Mr. Burch, had a talk two years ago about the American Mining Congress, and we agreed that it was deserving of support as an agency to represent the mining industry at Washington, and to do for the national industry what your California Metal Producers Association was doing in California. I would like to have your opinion as to the recent extension of the activities of the American Mining Congress in establishing bureaus for statistics and technical information on a somewhat grandiose scale.

I believe that, being in close touch with the various Government bureaus in Washington, it has a field of usefulness along the lines suggested, in the matter of collecting and disseminating information, not to the public nor to the mining public, but to members of Congress, who are sadly in need of correct information regarding the various measures that come up before that body. The field, you might perhaps consider, is fully occupied by the American Institute of Mining Engineers, scientific and technical publications, the Bureau of Mines, and the Geological Survey; but in my opinion there is still a good field for the activities of the American Mining Congress along the lines stated. It is a fact that can be seen by anyone who goes to attend committee hearings in Congress that little attention comparatively is paid to the statements made by the Bureau chiefs and Bureau employees as against statements made by rank outsiders, and since the American Mining Congress makes a specialty of looking after national legislation as it may affect the mining industry, it has to maintain a position ensuring its officers a respectful hearing. I may mention here that this has been accomplished largely by the efforts of James F. Callbreath. I believe that, if not carried too far, the expansion which has been commenced will be of added benefit. Mr. Callbreath has had to depend in the past largely upon his own ability to collect facts without much assistance and having now

the beginning of a corps of assistants he can save his time for more important work. What do you think about it?

I think you have stated the case correctly in the last sentence where you refer to the "more important work". It is a matter of relativity as to whether lobbying—using the word in a kindly sense—and the watching of legislation is not more important than the establishment of further statistical bureaus; but, of course, it may be said that the one cannot be done without the other; that is to say, the stirring of legislation is impossible without an adequate source of data such as the organization can collect for the purpose, so you and I shall agree that some of this expansion is warranted and that if it can be kept within bounds it may be worthy of support. What do you think members of Congress really want for their consideration of matters coming before them?

They really want accurate information on various subjects coming from people in whom they have confidence.

Does that mean that they have no confidence in the Bureau of Mines and the Geological Survey?

The experience to be had in the hearings in connection with the War Minerals Control Bill indicates clearly that Congressmen pay but little attention to statements of such eminent men as Van. H. Manning and George Otis Smith as compared with outsiders. The attitude of the average Congressmen is that the men in the Government bureaus are trying to get something for the bureaus, whether it is needed for the country or not, and he looks with suspicion on measures advocated by these bureaus. Whether right or wrong, that is the attitude of the average Congressman.

Would you advise a young man today to become a mining engineer?

If the young man has the physique necessary to stand a great deal of hardship in all kinds of climate, and also has some of the elements of a diplomat in his make-up, in addition to the technical knowledge which he will gain by taking a mining course, Yes; otherwise, I would say No. There is going to be a continued demand for mining engineers and continued call for young men

in minor capacities about the mines and mills. There are a great many more little places, or little positions, than there are big ones; too many of the men who enter upon the profession of a mining engineer get into ruts early in their careers and never seem to be able to extricate themselves. Just why this is, is hard to determine, but sometimes it is because of the difference in ability in different human beings; frequently it is a question of luck, and oftentimes it is due to the lack of diplomacy.

A WESTERN ENGINEER

*In this issue we resume our series of interviews with representative members of the profession. Our victim this time is Mr. Albert Burch, who embodies the best traditions of Western mining. He was born in the prairie-lands of Nebraska, far from any mines, and not even within sight of any mountain that could suggest either geologic disturbance or prospective digging. Like many others he entered mining through the door of surveying; in his case it was railroad work. He followed the rails into a mining district and shortly afterward was given his first opportunity to survey the workings of a mine, in Utah. That marked the beginning of his career as a mining engineer; he did not graduate from a school of mines or undergo any special academic preparation; he became a mining engineer by doing the work of a mining engineer, which, unquestionably, is one of the most effective methods of qualifying for the profession. He is one of those useful men who, starting with nothing more than high-school instruction, have made the most of the greater school of experience, aided by persistence and native intelligence, plus character. He became proficient technically by dint of study during spare time; to technical science he added an understanding of his fellow men—an essential knowledge. The leasing of a small mine on his own account was an experience that must have helped greatly in equipping him as an adviser to others. It was a personal venture—an adventure—and it gave him, we surmise, a first realization of the economics of mining and a keen appreciation of the fact that the basic purpose of mining is to make

*Editorial in the 'Mining and Scientific Press' of August 28, 1920.

money, not to furnish jobs for excellent young men. The appointment to the superintendency of the Bunker Hill was an important event in his life, because it enabled him to prove his mettle and enlarge his acquaintance among men of importance in Western mining. Mr. F. W. Bradley tells us how he came to know Mr. Burch through an experience that they shared while traveling in Oregon. They were overtaken by a snowstorm so violent that two of their horses succumbed, but eventually they reached the shelter of the cabin for which they were making, because Mr. Burch broke trail with indomitable courage. He showed similar courage and persistence while in charge at Kellogg; he used to go through the workings of the Bunker Hill twice a day. A capacity for hard work and long hours has stood him in good stead ever since. Fortunately he has been blessed with a fine physique, rendering him capable of great exertions. Mr. Oscar Hershey, his partner, tells us how as geologist to the Bunker Hill company he was called upon to take Mr. Burch into the field and show him the evidences of faulting. He led Mr. Burch first as rapidly as possible to the top of the highest peak in the district, and thereby ascertained that his associate's reputation for endurance was justified. In Colorado, one may notice the great number of wagon-roads leading to insignificant prospects, the cut made for the road in several instances being deeper than the prospect-hole. A mine-owner is said to have been asked to explain the anomaly. "Well", he replied, "you know here in Colorado we can't get an engineer to visit our mines unless we haul him up in a buggy." That may be apocryphal; evidently it is archaic; but in any event it does not apply to Mr. Burch. He would go on foot or on snowshoes, in a submarine or an aeroplane, if necessary, to reach his objective. He is extremely active in his professional work. When we meet him at intervals, on train or ferry, on his way to and from his office, we learn usually that he returned to town yesterday and is leaving tomorrow or the day after. He seems rarely to 'take five', or 'taper off', as the Cousin Jack says. Capacity for hard work will go far, but it is not enough. Our friend has powers of keen observation, quick thinking, and good judgment. An excellent engineering equipment, the reader will say. Besides these he has a good temper; he is not easily ruffled and is

kind to those with whom he comes in contact. One of his associates says that the only time he saw Mr. Burch lose his temper was at the close of a long hard trip over a muddy road in central Idaho. The driver persisted in whipping the horses, although it was manifest that they were doing their best. Finally they stalled. The driver proceeded to use his tongue and his whip with equal violence. Mr. Burch expressed his opinion scorchingly, and later ordered the staff at the mine to give the driver no more business. A decent consideration for mankind is shown in his replies to our queries dealing with the labor problem and welfare work. At Kellogg, Goldfield, and Plymouth he did much to establish pleasant relations between the company's representatives, the employees, and the people of the town. That is good management; without good-will it is impossible to ensure efficient work; the disagreements that cause so much loss of time and money play the part of the screw-driver thrown by a vicious boy into a delicate mechanism. Mr. Burch succeeded in his welfare work, as it is now called, because he was sincere in his purpose. Many similar attempts by company officials, presidents, managers, or superintendents, have failed because each lacked the genuine humane interest in the workers without which welfare work is a Dead Sea apple; or, to use the vernacular, it proves a lemon. The 'open shop' is a question that tests intellectual honesty, for most employers and managers do not face its implications fairly. If capital be organized, it is well that labor be organized also, in order to facilitate collective bargaining. The 'walking delegate', of course, prostitutes a workable arrangement to his own selfish purpose, using his agency to promote trouble rather than to smooth difficulties. Mr. Burch talks good sense on this matter. He has a characteristic that is the mark of the truly scientific mind—he is intellectually honest; he does not 'kid' himself as many well-meaning people do. Thus he is frank in deprecating the present method of obtaining evidence in apex suits; he suggests special courts for such litigation. We commend what he says to our readers. He is equally frank about the war-minerals business, which has left so many heart-burnings in its wake. He has no doubt in regard to the disingenuous effort of the gentlemen at Washington to restrict claims for compensation to those who were solicited personally by

Government officials, ignoring the larger number that were reached by official propaganda in the press. Twice in the course of the interview, Mr. Burch turned the tables on his interrogator, by asking questions himself. That made the performance more natural, for every man likes to retaliate after a while. The interview should appeal to the young men of the West, because it tells how one of them 'made good' and achieved success. Mr. Burch has definite ideas concerning the kind of young man that ought to go into mining as a profession. He specifies the qualifications, but, naturally, he does not stress the special ones that helped him to succeed. One can learn to work hard, to observe accurately, even to think honestly, but the force of character that opens the ways of the world to a true man is not acquired at school or at college. "Which of you by taking thought can add one cubit unto his stature?"

CHARLES BUTTERS

AN INTERVIEW

The actions of some people are significant. They have the faculty of anticipating next year's almanac. Charles Butters is an engineer whom I have always credited with a kind of technical prescience, a keen sensibility for the metallurgical requirements of tomorrow. His career is full of episodes that confirm this friendly guess of mine. Just now we appear to be about to make a critical turn in metallurgical advance. He is my neighbor. Why not ask him to express his views in writing, more particularly as he is conducting experiments on the very process that threatens to revolutionize the treatment of ores, as MacArthur's cyanide process did 25 years ago. But like other men of alert mind and fluent speech, he dislikes to write. He cannot be persuaded to prepare an article. Well, if not in that way, then in another way it is possible to elicit valuable information. I asked him to submit to an interview—a friendly interview—by one who appreciated his useful work and desired greatly to give the benefit of it to the profession of which he is a distinguished leader. He yielded to my importunity.

You were born in California?

No I was born at Haverhill, Massachusetts, in 1854 and came out to California when 10 years old. My father brought me. He was a leather manufacturer, but immediately after arrival here he started mining in Placer county. He was over 50 then and really was too old to go into a new business.

You seem to have inherited his initiative. You graduated at the University of California?

Yes, in 1879. After graduation I went to New Almaden, in Santa Clara county, as chemist to the New Almaden Quicksilver Mining Co. But I was not long there; getting a better offer from my brother Henry, I left California and went to Fairplay, in Colorado, where I established an engineering (that is, surveying and assaying) office with William H. Leffingwell,

a class-mate of mine at the University. But our partnership was short-lived, because I saw an abandoned gold-mill of which I thought I could make a success.

What happened?

I fitted up the mill and treated 30 tons—and went broke. That's the way to learn. Then I obtained a position as assayer and metallurgist in a silver-mill in Frying Pan gulch, just outside Leadville.

When was that?

In 1881. Having treated 30 tons of ore in my own mill and gone broke in the attempt, I thought I knew enough to run the other fellow's mill. But in the interval I had visited every silver-mill there was in Colorado and studied their methods carefully.

So you succeeded this time?

Yes. I remember that David Brunton visited me at that time and complimented me on my work. The firm of Taylor & Brunton was of great help to me; both partners were thoroughly informed concerning the metallurgy of silver, and they were very kind to me.

How long were you at Leadville?

About a year and a half. Then I went to the Holy Cross district and started a 20-stamp gold-mill with plain amalgamation. From there I went to New York as agent for a San Francisco firm, the Pacific Iron Works. That was in the latter part of 1882. I didn't like the work at all; I was a metallurgist, not a salesman. However, I made the acquaintance of a lot of useful people. I made it my business to know all the mining engineers and people connected with the mining business. I can say that I always made it a point in my youth to make the acquaintance of the ablest men in my profession and I preferred to work for them at a comparatively small salary, rather than work for the non-technical public. I was criticized by some of my friends, who said that I could never make any money in that way, but the result of this policy was that I found myself working for Stetefeldt, Clarence King, Stephen Krom (who invented the rolls), Fraser & Chalmers, R. P. Rothwell, and Walter Mc-

Dermott. McDermott was specially kind to me and put me onto the San Sebastian mine, of which I will tell you shortly. William Frecheville was another good friend; he was then in North Carolina, and employed me in expert work, that is, ore-treatment.

So you left New York soon?

Yes, and went back to Colorado, where I started a silver-mill, a custom plant, at Crested Butte, for a New York company.

What mill was that?

It belonged to Commodore Webb of New York and treated ore from the Ruby Silver and other mines. I worked all the ores in the district by dry crushing in a stamp-battery, roasting in Bruckner furnaces, and amalgamating in pans.

The crushing dry under stamps was tough?

Awful. No crushing capacity, and no end of dust.

How long did that last?

About a year. Then I returned to New York and opened an office on my own account. That was in 1883. I shared a laboratory with Krom. We did general metallurgical work. I found a process for treating the San Sebastian ore.

What was the difficulty?

We could not amalgamate it. If we tried to concentrate, we lost about 80% of the gold with the slime. This was due to the combination of the gold with tellurium, which also was combined with the copper, as the mineral rickardite—a fact that we discovered in later years. The ore also contained molybdenite.

How did you solve it?

I found that it could be treated readily by chlorination. I treated five tons in New York and then made a contract to build a mill for the company.

Where did you get your experience in chlorination?

A few months before I had made a honeymoon trip to North Carolina and taken charge of the Designolle reduction

works, belonging to P. Bechet et Cie., a French banking firm. At that custom mill they bought various concentrates and roasted them; then the roasted concentrate underwent amalgamation with mercuric chloride in barrels. It was a wretched failure. The company failed, and left me strapped. All that I had on hand was 20 tons of residue in the form of roasted concentrate running a little over $15 per ton. In order to get back to New York with my wife and mother, I had to find a method of extracting that $300 worth of gold.

What did you do?

I commenced to experiment in the laboratory by aid of a glass funnel and one pound of the roasted ore. By saturating the ore with chlorine gas, after a couple of days I extracted the gold out of that pound of ore. Thereupon I took 100 lb. and contrived a generator, attempting to treat it in the half of a small oil-barrel. After two weeks of vain effort I found that I could not saturate the stuff with chlorine gas. Finally I ascertained that the roasting previously done in the mill had been most imperfect. Thus, by experimenting on the 100 lb. of residue, I ascertained the absolute necessity of a dead sweet roast. At once I re-roasted the 20 tons and by the aid of eight oil-barrels I built a little chlorination plant. In the end I had 100 slugs each representing $3 in gold. I sold some of them at the Charlotte mint and thus got enough money to pay for the journey to New York and make a fresh start. After that I was a chlorination expert. When the San Sebastian ore came to me, I was ready to apply chlorination.

So you went then to Salvador?

Yes; and built a 30-ton chlorination plant, which was entirely successful. They paid me $1000 per month. I was then 31. I remained two and one-half years.

Then?

I returned to California and went to Kennett, in Shasta county, where I established a chlorination plant. This was in 1887. We extracted gold, silver, and copper. We received ores from distant localities, such as Grass Valley; for instance, from the Coleman brothers, who controlled the Idaho mine.

Was that enterprise successful?

Yes, metallurgically. I treated some most difficult ores, but I could not get enough business, so it was a hard pull. Incidentally, I treated several hundred tons of wet raw tailing running $4 to $5 in gold with very slight impregnation of chlorine gas and obtained an almost complete extraction. After I had been there about two years and spent all my money and my plant had been seized by the sheriff—but I got out of that—Huntington & Hopkins protected me till I was on my feet again.

It was about time for another migration, was it not?

You have guessed right. At the end of 1889 Professor Christy appeared suddenly one morning as I was laying pipe in a ditch, in the rain. He told me that he had received a cablegram from Henry C. Perkins, asking for a man to go to South Africa. The qualification specified that the man was one that owned his own reduction works.

You agreed to go?

Instantly; without a second thought. I felt perfectly competent to do the work. My wife and I proceeded to Johannesburg by way of London.

There you built the chlorination plant at the Robinson?

Yes. I was assistant to Hennen Jennings, who was consulting engineer to H. Eckstein & Co. It was on Jennings' initiative that Perkins had cabled to Christy.

This plant was successful?

The Robinson chlorination mill was successful from the very start. I had the pleasure of making the first bar of gold produced by the chlorination process in South Africa.

You remained there some time?

Yes; I ran that plant until 1894, when I resigned and organized the Rand Central Ore Reduction Company.

On your own account?

Largely; this was a custom chlorination and cyanidation plant, with a refinery—it was a general metallurgical establishment. We bought all kinds of by-products. I was managing director for five years.

When did you first come in touch with the cyanide process?

At the end of 1890, nearly a year after my arrival at Johannesburg. The Cassel people had just completed a local plant to treat 1600 tons per month of stamp-mill tailing.

You studied that?

Certainly. I watched it most suspiciously. But when the clean-up was made, at the end of the first month, I was absolutely satisfied that the cyanide process was the most wonderful I had ever seen. I realized that it would kill chlorination and revolutionize metallurgical practice on the Rand. Immediately I hastened to urge the Ecksteins to buy the rights to the process in South Africa.

What happened?

They thought I was too quick in my judgment. Shortly afterward the owners of the patents realized the importance of the process and it could not be bought at any price.

Therefore, I suppose, you used cyanidation yourself in the big custom plant you built in the Central Rand?

Yes; immediately after Jennings realized what cyanide meant, he ordered me to design a plant to treat the entire Robinson output. At that time the Robinson had 40 stamps.

You designed that cyanide plant also?

Yes; and to show what metallurgical progress meant to the Robinson I can say that the mill was producng 4000 ounces of gold at the commencement of 1890, while in 1892 the mill was producing 8000 ounces and the chlorination plant 8000 more.

How were chlorination and cyanidation combined?

We concentrated the gold-bearing pyrite on Frue vanners, getting a 5-oz. concentrate, which was treated in the chlorination plant, while the residue was delivered to the cyanide annex.

So cyanidation was only applied to the residue?

At that time. Of course, a few years later the concentration of the pyrite was stopped and everything cyanided, after finer crushing.

How long were you on the Rand?

About eight years. Then I returned to America, bought the San Sebastian mine, and organized the firm of Charles Butters & Co., Ltd., in London.

You had kept in touch with the San Sebastian?

Through all those years. I believed it to be a great property that had been grossly mismanaged. In association with David J. Pullinger, of Johannesburg, I paid $100,000 for it, and within a year had $1,000,000 worth of 3-oz. gold ore in reserve.

What has it done since?

It has produced over $10,000,000, half of which has been distributed in dividends.

Did you remain long in Salvador?

I stayed there less than a year the first time, getting the enterprise fairly started. We erected a cyanide plant first to treat 20, then 40 tons, per day, increasing the capacity finally to 120 tons per day.

What was your next metallurgical departure?

I went to Mexico and established a cyanide plant at Minas Prietas, in Sonora. This was built to treat the dumps and the tailing from an amalgamation mill belonging to the Grand Central mine.

Was there anything special about that plant?

It was the first in Mexico to treat slime by agitation and cyanidation. From there my assistants, E. M. Hamilton and C. G. Patterson, went to Guanajuato, to erect a similar plant.

When did you develop your vacuum-filter?

Soon after the Prietas mill was finished—in 1901—I built a slime-plant at Virginia City, to treat the old Comstock dumps. This material was a sticky stuff, much oxidized, colloidal, very tenacious, and hard to settle. I made a complete fizzle of the job at first, losing $100,000 in the first year. Altogether we lost $475,000, which was the price for learning how to filter slime. I developed my system of filtration, and in doing so I was assisted particularly by Mr. Patterson. Since then he has erected a number of similar plants in South Africa. As a sequel

to our experience at Virginia City, all the Tonopah plants, particularly the Tonopah mill at Miller's, were designed. This was done in 1907 after we had treated 50,000 tons of their ore at Virginia City.

Eventually your work brought you into conflict with the Moore patents?

Yes, unfortunately. The courts gave an adverse decision in 1911.

Whereupon you turned your attention to a new field of research?

I continued research into the physical condition of slime. To obtain the latest information, I went to Germany, on the suggestion of my friend, H. L. Sulman, of London, and interviewed the great specialist in colloidal chemistry, Dr. G. Bredig of Karlsruhe. I arranged with him for a series of investigations into the physical characteristics of metallurgical slime. But the War stopped that.

When did you become interested in concentration by flotation with oil?

In 1899, as soon as I heard of Elmore's first work with this process in Wales, I went down there to see it and became sufficiently interested to make a contract with him to introduce flotation into the United States and Mexico. I have here now the first flotation plant made in the United States. It used to be in the basement of the Dooly building at Salt Lake City and consists of a cylindrical mixer with a centrifugal machine to separate the excess oil from the concentrate. That process was really 'oil flotation'—the floating of the sulphide mineral in an excess of oil on the top of the pulp.

Why did you drop it?

I could get no better results than by ordinary water concentration.

On what ores did you try it?

Anaconda ore and slime, also various copper ores from Bingham. We did not understand oiling at that time—this was 15 years ago—nor did we appreciate the necessity for making

a froth. The excess of oil we used—20 lb. per ton of ore—made a fearful mess.

It did not attract you then?

It was impracticable in the form then adopted.

What did you do next?

In June 1914 I engaged the firm of Sulman & Picard to do some experimental work for me on the application of flotation to residues from the Nipissing mill, at Cobalt. The results were so startling that, at the first opportunity, I got into touch with the Minerals Separation Company with a view to making systematic tests with flotation on the ores of various mines in which I am interested, such as the San Sebastian and Devisadero in Salvador, the Copala in Mexico, and so forth.

You returned to California?

Yes, I came to San Francisco and worked for a month in the laboratory of E. H. Nutter, the representative here of the Minerals Separation Company. I perceived at once that the field of experimentation was very wide, so I arranged with Mr. Nutter for the loan of one of his company experts, F. A. Beauchamp, and established a flotation department in my home laboratory here at Berkeley.

You have obtained interesting results?

Since we started we have made determinations on ores from widely separated mining regions. At the start these tests were made on 500 grammes, and yielded remarkable results. But tests on pound samples did not satisfy me, so we built a machine to treat 10 to 15 lb. From that we proceeded to make an apparatus capable of treating lots of any size. We are about to make considerable additions to our flotation plant.

How much oil do you use?

In our experiments we have been using from ½ to 1½ lb. per ton of ore.

How much acid?

None. We work in an alkaline solution.

Did you experiment on the subsequent treatment of your product, namely, the concentrate from flotation?

Of course. To our complete surprise we found ourselves unable to cyanide the concentrate produced by flotation. If this product can be shipped to a smelter, it is a simple matter, but in many cases it is imperative that the concentrate be treated on the spot. Evidently, if it be the oil that prevents cyanidation, we might produce the concentrate by the use of soluble oils in the flotation process, but, so far as our results go, the class of oil that produces the cleanest concentrate is just the one that we are unable to dissolve.

That is an important fact.

Yes; as you have often said, "The failures are as interesting as the successes". We shall be prepared to give you full particulars for publication. J. E. Clennell has made a great number of tests and the description of his work will prove useful to the profession, I feel sure.

Can you produce a richer product by flotation than by water concentration?

In all our work, the first thing we aim to obtain is a rich concentrate and a residue that can be discarded. When this can be done, the treatment of a gold and silver ore is tremendously simplified.

You have done this in some cases?

We can do it on a silver ore, if it is not too much oxidized. Even on surface ores some of our results are surprisingly good. For instance, take the old dumps that have been mined, milled, and re-concentrated at Virginia City for the last thirty years. We can get a high-grade concentrate and a comparatively low residue even on this material; that is, we can take material assaying $5 per ton and impoverish it down to $1.50 per ton while getting a $170 concentrate. But even this will not compete with cyanidation, because I cannot treat that concentrate. I can ship it to the smelter, but the freight and smelter charges, plus the $1.50 in the residue, represent something like $16.50 as against the 75 cents per ton lost in the cyanide tailing.

How about Mexican silver ores?

On ores such as those of Copala, in Sinaloa, I can obtain a high-grade concentrate, even from the dumps. For instance, on what we call the *colorada manta* the results are:

	Gold oz. per ton	Silver oz. per ton
Original ore	0.10	10.10
Concentrate	0.84	198.48
Tailing	0.01	0.15

One would think that as this ore is almost completely oxidized it would give trouble, but the silver has been left in such a condition that it can be floated, probably as argentite.

You get better results on sulphide ore?

Naturally, when unoxidized the ore presents no difficulty. For example, a sample from the dump at the San Carlos adit at Copala gave these results:

	Gold oz.	Silver oz.
Original ore	0.11	15.60
Concentrate	3.58	468.14
Tailing	0.02	1.48

Then flotation promises to have a wide application?

One cannot say that it is a panacea for all kinds of metallurgical troubles, but it is a process that every metallurgist must study, because if he does not ascertain whether there is a place for it in his flow-sheet he will be missing big chances.

But the difficulty of treating the flotation concentrate?

On a gold concentrate like that from San Sebastian ore we can get a high extraction by cyanide, after roasting, but where both silver and gold are present our results are poor. Take, for example, the roasting tests on flotation concentrate from Vir-

ginia City, assaying 2 oz. gold and 182.44 oz. silver, we obtained these results:

Treatment	Gold %	Silver %
1. Oxidizing roast, following by sulphuric acid wash, then cyanidation	90.5	19.7
2. Plain oxidizing roast, without acid wash, then cyanidation..	75.5	6.7
3. Oxidizing roast, followed by chloridizing (5% salt) roast, then cyanidation	80.5	75.6
4. Raw cyaniding	35	5.75
5. Following this with a chloridizing roast, and further cyanidation, we obtained additional	13	23.45
Thus by 4 and 5 combined......	48	29.2

The metallurgical treatment of flotation concentrate is an entirely new subject.

Is it a question of expelling the oil in the concentrate?

I do not know.

Is it not possible to find a solvent for the oil?

I should say that it might be easier to use an oil we could dissolve than it would be to find a solvent for the oils we use, but, as I have already stated, up to the present, the best results are obtained with insoluble oils consisting essentially of tar products.

Is that because the insoluble oil gives you stronger bubbles in the froth?

Yes, the insoluble oils are better collectors of the sulphide mineral; such oil is added just to give the froth sufficient volume to constitute a convenient vehicle for the removal of the oiled mineral.

Do you apply flotation to the tailing or to the crude of San Sebastian, for instance?

Our average residue at San Sebastian after cyaniding is $2.16 per ton. We can reduce that by flotation to 20c. per ton and obtain a concentrate assaying $7 to $18 per ton, depending upon the part of the mine from which the ore comes. The ore itself can be subjected to flotation so as to yield a tailing assaying from 75c. to $1 per ton on an original ore assaying $20 per ton.

So that, if you knew how to extract the precious metals in your flotation concentrate, you would proceed to use flotation before cyanidation?

With cyanide we get residue of about $2 per ton. In our flotation tests we obtain an extration of 95% at once, leaving a tailing containing $1 per ton. We find that by roasting at a temperature not to exceed 600° C. the copper is left as a sulphate. By washing thoroughly with water, we extract 10 lb. copper per ton and then reduce the flotation concentrate by cyanidation from $100 to $1 per ton.

Does the question of cost arise?

We figure that we would gain about $2 profit per ton by using flotation as described.

How about the chemicals required?

We would use about half a pound of oil per ton, as against five pounds of cyanide. We would have to use cyanide for the treatment of the concentrate, but it would be only 2 lb. per ton and the concentration would be in the ratio of 4 to 1, that is, half a pound of cyanide per ton of crude ore.

You have experimented on the ores of other mines besides your own?

Certainly, enough to indicate that every silver-mill, at least, should ascertain whether flotation is applicable. For example, we tried the ore of another mine in Sinaloa. The results were:

	Gold oz. per ton	Silver oz. per ton.
Original ore	0.52	15.94
Concentrate	8.16	242.36
Tailing	0.035	2.07

These figures indicate that it would be possible to beneficiate

an enormous quantity of low-grade ore not available hitherto for treatment, without additional capital expenditure for power.

I presume you have not decided what is the best type of mixing machine?

We realize the necessity for a most intimate mixing of oil and ore, after which quiescence is necessary in order that the bubbles may not be broken, thus facilitating a cleaner separation. It seems to me that the two stages of treatment should not take place in the same machine.

Do you prefer the pneumatic or the mechanical agitation?

All the work done in this laboratory up to date has been performed with the Minerals Separation machine. At present, with my limited knowledge of the process, I would say that mechanical agitation is best for the oiling stage, because it is more positive in its action. George O. Bradley was kind enough to show me a new positive oiling machine that he has devised; it impressed me as likely to prove effective. I believe that J. M. Callow's idea of separation in tank-like cells is sound. We are now installing a complete set of Callow apparatus. He has shown that mechanical mixing is not necessary in certain cases of copper ore, but the problems arising from the treatment of copper ores are quite different from those to which I have devoted myself. The proportion of mineral to be extracted from a gold and silver ore is extremely small as compared with that obtained from a copper ore. The froth required for the separation of precious-metal sulphides is more delicate and requires different handling.

As to the various oils?

During a recent visit to Salt Lake, R. C. Gemmell was kind enough to permit me to visit the Arthur plant, where I met F. G. Janney, Jr. Frankly I was dumbfounded to see what a lot of work he had done on the subject. Mr. Janney has established a laboratory for the analysis of flotation oils and has records of over 500 oils already. This is work of supreme importance, for he is ascertaining what are the elements in the various oils that accomplish given results.

Some ores require an acid and others an alkaline treatment, do they not?

Undoubtedly some ores work better in an acid medium, but as I realized how much greater is the ease with which an alkaline solution can be handled in a mill, I have not rested content with any acid treatment. In every case we worked out our results in an alkaline solution. In fact, if cyanidation is to follow flotation I consider it essential to perform the flotation in an alkaline solution; but, you understand, I refer to gold and silver ores only, not copper ores.

Finally, Mr. Butters, you are much impressed with the importance of flotation?

Yes, indeed. I am convinced of the far-reaching importance of the process. It has started a new era in the concentration of ores.

THE NEW METALLURGY

*In this issue we publish an interview with Mr. Charles Butters. We feel sure that it will interest our readers, particularly the many friends of Mr. Butters in various parts of the world. To the younger men it should be a delight to read how one of their recognized leaders utilized the experince of life to such manifest advantage. On its human side the story proves that the mistakes of a sagacious man are merely stepping-stones to success. It also affords a striking example of that intensely American characteristic: the willingness to scrap anything that is useless in order to make way for something that is useful. The enterprise and initiative of our metallurgical hero furnish a splendid example to youth; to older men his quick decisions seem like playing with fate. It is not too much to say that in his eagerness to learn and his daring to put thought into action, Mr. Butters is a fit exponent of the modern idea at its best. Leaving the human side of the story, we turn to the technical. From amalgamation to chlorination, from chlorination to cyanidation, this eager seeker of applied knowledge has progressed. Now no longer young, he finds himself facing a new departure: a new process that promises to

*Editorial in the 'Mining and Scientific Press' of August 21, 1915.

revolutionize the concentration of ores on a world-wide scale. Does he feel annoyed to have his personal experience with other processes seemingly set to one side? No, with all the joyousness of a keen student he enlarges his home laboratory and organizes a staff for earnest research. Testing the slime and other mill-products from the mines in which he is financially interested, he ascertains the applicability of the flotation process. Meanwhile samples of ore are sent to him from widely separated localities and upon them also he tries the effects of flotation. A metallurgical vedette, he is determined to keep in the van of progress. To us, and to our readers, we feel assured, this episode is both interesting and significant.

The information given by him concerning flotation is timely. It will be noted that the experiments made at Berkeley are all done with alkaline solutions. This in itself is noteworthy, for the use of acid has been a prominent feature of earlier flotation processes, because the acid accentuated the selective adhesiveness of oil for metallic particles as compared with the earthy gangue-minerals. But the most interesting information given in the interview is that dealing with the flotation concentrate. So far, at the lead-zinc mines of Broken Hill and at the big American copper mines using the process, the question of treating the concentrate itself has been shelved, for a ready market was furnished by the smelters. In many isolated localities, in Mexico or the West, the reduction of the concentrate on the spot is advisable, if not imperative. As to this, Mr. Butters makes some suggestions. Moreover, his frank acknowledgment of lack of knowledge concerning certain phases of the process is instructive. As a matter of fact, the technology of flotation thus far has been mainly developed in the wake of a peculiarly vindictive litigation. The Law is not a good teacher of science. Indeed, of the literature of the subject to date it can be said that nine-tenths of it is hopelessly vitiated by the prejudices of patentees, process-mongers, and litigants. Most of the men experienced in the flotation process are either tied to the company claiming a monopoly in the use of it, or they are in the employ of the companies that are contesting that monopoly. In consequence, the amount of reliable information available is small. The metallurgists who have been largely instrumental in developing the agitation-froth process are under orders not to write or talk, for fear

that they may hurt the cause of their employers in lawsuits now pending, and that have always been pending since flotation—whether by oil, gas, or froth—first became of any consequence. On the other hand, the metallurgists and millmen associated with those who are confessedly infringing the disputed patents are in no position to give the profession the benefit of their experience with such frankness as they—and we—would desire. Meanwhile, if the mining industry is not to suffer, we must all try to break this embargo on knowledge. The 'Mining and Scientific Press' has done so lately, not without success. And without injury to anyone. Our aim is to be helpful to many and injurious to none. Our sympathy goes to the clever men, especially those connected with the Minerals Separation company, that are unable to expound the technology of the process or win the distinction that comes to specialists in a branch of the art growing rapidly in importance. We sympathize likewise with those who are making preliminary tests with flotation on their own ore and find it difficult to get proper guidance. With the assistance of a few independent investigators, we shall hope to remedy that deficiency. It is the province of technical journalism to gather information where it can, for the general good, and serve as a clearing-house of ideas to the professional men scattered among those widely-separated localities where the metals are won from Nature. The least that we can do is the best that we can do. The need for information is urgent. At a time when the base metals are intensively demanded for warfare, and in preparation for a time when they will be in still greater demand for peaceful purposes, it is peculiarly unfortunate that a process of apparently such wide usefulness should be stifled in the ill-ventilated atmosphere of the law-courts. In our next issue we shall publish an article on flotation at Anaconda by Mr. F. P. Mathewson and in subsequent issues we shall make further efforts to give our readers the latest information on a process, that, as Mr. Butters says, "has started a new era in the concentration of ores".

JOHN M. CALLOW

AN INTERVIEW

You were born in the old country?

I was born in the village of North Repps in the county of Norfolk, within sound of the North Sea.

At what date?

July 7, 1867.

Was your father connected with engineering?

No, my father was a large farmer and a land-owner, so that I was a farmer's son.

What was your early education?

The ordinary English grammar-school education until I was 16. Then I was articled as an engineer to a firm of engineers in the city of Norwich.

You supplemented your apprenticeship by further study, I presume?

I took an engineering course in the Norwich School of Art, and the South Kensington examinations in applied science. This entailed a great deal of study by night and my health suffered, so that our family physician advised my father to send me on a sea voyage. He bought me a ticket on a sailing ship for Australia and gave me a letter of credit for about $500. I sailed for Australia in the year 1885 on the sailing ship 'Superb', which was one of the old Black Wall liners, and was originally an East India troop-ship. The voyage was full of experience for me, as we were two weeks beating down the English Channel to Plymouth, where I first got my 'sea legs', and we were three and one-half months from Plymouth into Melbourne harbor.

Did you try to get employment?

Not at this time, as I still had some funds. I visited the min-

ing camps of Ballarat and Clunes, and saw my first mining. From there I went on a visit to Tasmania and stayed for some weeks at Triabunna Bay on the east coast, close to the old convict settlements of Maria Island. From there I went to Sydney and afterward to Brisbane and the Darling Downs district; then to Townsville and from there to Charters Towers, where I met a man from my own village.

Did he help you?

Yes; through his kindness, I spent some weeks on a cattle station on the Burdekin river among the Myall blacks.

You did not go to the mines at Charters Towers?

I visited all the principal mines at Charters Towers, and, I remember also, the small smelter at Ravenswood. About this time, I was 'broke', so I sought employment, and got a job in Plant's mill.

Do you remember the name of the mine?

No; my recollection is that it was a custom mill.

Probably the Day Dawn, for I can tell you that I met E. H. T. Plant at Charters Towers four years after the date you mention, by which time the Day Dawn had become a big mine. Mr. Plant was also a director of the Brilliant Gold Mining Co., which at one time ranked first among the gold-producers of Australia. What was your job?

Just a roustabout around the mill. This was a small stamp-mill employing amalgamation followed by Berdan pans and Gilpin county bumping-tables.

I doubt that. The Gilpin county bumping-table was not known in Australia at that time, but they had a machine called the Halley table, which needed a small boy to look after it; from our point of view, it was ridiculous in requiring the constant supervision of a small boy to remove the concentrate. Did you become interested in your work?

Of course. All this work was of much interest to me because of my training as a mechanical engineer. After working at Charters Towers for about two months, I received a welcome remittance from my father, with instructions to be sure to come

home and finish my education. I had just enough money left to take a passage from Townsville back to England, this time in the steamer 'Dacca'. We called at Bowen, Thursday Island, Batavia, Colombo, Aden, Suez, Port Said, and Malta. It was a wonderful voyage, lasting two months. The scenes and events were impressed on me indelibly. The 'Dacca' soon afterward went down in the Red Sea, but I landed safely at Tilbury dock on October 4, 1886, dressed in true Queensland fashion and with a miscellaneous collection of souvenirs, including boomerangs, spears, and a Maltese poodle. I went back to work with my old firm, Riches & Watt, at Norwich, staying with them until I was 21, by which time I had completed my apprenticeship.

So now you were ready to make a new start?

Yes; but having seen something of the world on my Australian trip, I was anxious to see more of it; therefore, on the first excuse, I sailed, in October 1888, for New York, heading for Colorado, where I had relatives. My health still was none too good, and the doctors advised me to lead an out-door life for a time, so I went to Eaton, about 60 miles north of Denver, and, having a little money, I went into partnership with my cousin, as a renter on 80 acres of land—he to do the work, and I to furnish the money. We 'batched' in a tent in summer and a dug-out in winter. The venture was so successful that I decided to buy some land, and I bought 160 acres of raw land with water-rights from the Colorado Mortgage & Investment Co. and immediately went to work to improve it. Here I learned to ride, to drive a four-horse team, to plow, irrigate, and other rural accomplishments, and for two years followed the regular life of a farmer. I had this farm for 13 years, and it proved a successful investment. During my stay on the farm, I ran across Mrs. Mary Lease, 'the Kansas cyclone', a political lecturer, and one of the main expounders of the Farmers Alliance doctrine. I accompanied her on her lecturing tour through that part of the State, and she influenced me to stop farming and go back to my profession, which she thought offered me a better scope. Shortly afterward, happening to be in Pueblo, I called on the Stearns-Roger Manufacturing Co. and met John Roger, who gave me my first job as a draftsman. I stayed there a year; then, the farm having been quite successful, I decided to go home. Before returning I

was married to Miss Roberta A. M. More, whom I had long known and who was a sister of an old friend of mine, Thomas More, a pupil, like myself, of the engineering firm at Norwich. We settled at Denver, and I went back to work for the Stearns-Roger Manufacturing Co. in its Denver office in 1893. Here I first got acquainted with Thomas B. Stearns, and, I am proud to say, we have been good friends ever since. Unfortunately, the silver panic of 1893 affected the firm, as it did everybody else, so that they had to decrease their force, and I had to shift for myself again.

Yes, I know all about the silver panic, because it hit me in the same way. What did you do?

For a year I did practically nothing, except odd jobs as a draftsman around Denver, but in '94, I went to work for Philip Argall in the designing of the Metallic Extraction Co.'s works near Florence, Colorado. By the way, I also wish to say that on and off I worked for the late Henry Vezin, whom I held in great esteem, and from whom I benefited greatly on account of his wide technical knowledge. Here I may also record my many obligations to Mr. Argall, and the experience gained under his direction.

Did you have anything to do with the running of the cyanide plant?

No. I left before the large plant was completed, and got into a mining venture in San Juan county, near Silverton.

What was the name of the mine?

It was owned by a company known as the Golden Horn, operating in Ice Lake basin overlooking Ophir. Some of my English relatives and friends had put up the money. We built a mill and worked the mine to a limited extent, operating for a time with pack-trains.

Shipping concentrate?

Yes, shipping concentrates to Durango, and bullion to the Denver mint. The venture was not successful owing to lack of capital, but I obtained much valuable experience in the rudiments of mining. I still own the property, and expect its value to appreciate some day. My wife and I had many inter-

esting experiences there, for we lived at the mill, which was just below timberline.

That would be 11,000 ft., would it not?

The mine was at something like 13,000 ft. and in a wild and snowy country, and the mill some 2000 ft. lower. After the shutting down of this enterprise, I returned to Denver and soon afterward came to Utah for the purpose of re-designing the old Highland Boy cyanide mill into a concentrating plant. This put me in touch with Thomas Weir and Samuel Newhouse, both of them energetic and well-known mining operators in the West. I joined the staff of Mr. Newhouse and did some of the early experimental work on the ores of the Boston Consolidated, at Bingham, and of the Cactus mine at Milford. Later, I was designing engineer for the Annie Laurie Mining Co., operating in Sevier county, Utah, owned by P. L. Kimberly. This was a dry-crushing cyanide plant and followed Cripple Creek practice as laid down by Mr. Argall.

So you had some of the earliest experience in the treatment of porphyry ores?

The Bingham porphyries were just beginning to attract attention and I set up a little laboratory in the Dooly block to do jigging and panning tests on this ore. It was soon evident that the mineral was much too finely disseminated for a jigging operation, and the flow-sheet that I finally developed was one employing fine crushing and tables.

What kind of crushers and what kind of tables?

We proposed to use rolls followed by Chilean or Huntington mills, thence to hydraulic classifiers and Wilfley tables, thickening the slime in tanks and finally treating it on vanners, which were, at the time, the only machines adapted to the work. The recoveries, as I remember them, were around 75% ; the result was a 30% concentrate from a 1.3% ore. I remember drawing up plans along these lines for the Boston Consolidated company, but they were never executed. At about this time I met Colonel Wall at Bingham. He was then prospecting the ground now owned by the Utah Copper Company and was testing the ore in the old Rogers mill in Bingham canyon. I remember well his enthusiasm and faith in what was then facetiously known as

'Wall-rock'—a faith which in later years has been more than justified. Later on, Mr. Jackling repeated these tests in the same mill and eventually launched the Utah Copper Company and built the experimental plant at Copperton. About the same time, I was constructing the Yampa smelter for George Robinson, Jim Neill, and their associates. George Robinson has since 'gone West', but Uncle Jim is still very much alive and a much esteemed friend.

What did you do at the Cactus?

I tested the ore, prepared the flow-sheet, and designed the mill, which was built by Bettles.

This mill was based on your own experimental work?

Yes, it was. The flow-sheet consisted of rolls, jigs, tables, and vanners.

When did you invent the Callow cone?

At about this time. I found the necessity for some settling device in mills employing fine crushing, and I had long appreciated the necessity for getting the slimy pulp to the proper density in order to do good work on the de-sliming machines. The first Callow tank was installed in the Cactus experimental mill, which I erected close to the mine for the purpose of testing the flow-sheet that had been planned in the laboratory.

Did you invent or design any other mechanical improvements?

About this time, I began to appreciate the great importance of sizing for table work. Out of this grew the invention known as the Callow screen, which is a traveling belt of screen-cloth on which pulp is spread, the over-size being retained on the traveling screen and the under-size passing through the meshes. These two devices—the screen and the tank—I turned over to the Galigher Machinery Co., as manufacturer and agent, and for some time personally pushed these two inventions. They have had a wide application and served a useful purpose in their time. The Callow tank, of course, has since been replaced to a large extent by the Dorr thickener; and the screen, while still of considerable value in some positions in mills, has been set aside by the developments that have taken place in the roughing system of concentration.

How long did you remain with the Newhouse organization?

I must have been with Newhouse for two or three years. and then I set up in business for myself at Salt Lake City, in 1906, under the name of the General Engineering Company. We erected our own building and went into the regular ore-testing business. Shortly afterward, my brother Frank and Ernest Gayford became associated with me, we having all been school-boys together.

In connection with your testing operations, you must have gathered a great deal of technical information?

Yes, from the time I started with the Stearns-Roger company until now, some 14 or 15 years had elapsed, during all of which time I had been very active—to an extent, of course, impossible to detail here. I had long appreciated the importance of test-work preliminary to full-scale operations and had realized that the many failures to be seen throughout the country were due to the lack of testing, and that by the application of scientific knowledge and skill in the early stages most of these mistakes could be avoided. It seemed to me, therefore, that a testing plant, and work of this kind, would offer a good opportunity for business, as well as the acquirement of useful information.

When did you become interested in flotation?

In the year 1909. Of course, I had become cognizant of the subject from reading the technical papers, and, afterward, from the introduction of the process at the Butte & Superior mill, in 1911.

But surely, you must have heard of the early attempts with the Elmore process, because Butters had a plant in Salt Lake City.

Yes. That reminds me; at about this time, I made the acquaintance of Stanley Macquisten, and we did a large amount of test-work for him with his tube, which was a most ingenious device, and quite effective on some kinds of feed. From the Macquisten tubes, we were led to experiment with agitation flotation; we built machines and tried them in our laboratory, obtaining results that gave us a proper appreciation of the possibilities of this process as compared with gravity slime-treatment.

So that caused you to experiment further with the froth-agitation process as distinguished from the old methods of Macquisten and Elmore?

Yes. I soon realized that the principal feature of the froth process was the introduction of the air, for to a man of mechanical instincts, it was self-evident that the propeller was a most clumsy method of accomplishing the purpose. A few years previous, I had occasion to design a filter employing a porous brick for the aeration of cyanide solutions, and this suggested the porous brick as a medium through which to introduce the air into the pulp for the purpose of making bubbles. Remembering that William H. Creden of the Davis-Daly Copper Co., of Butte, had one of these bricks in his office, I telegraphed to him for it, put it in the bottom of a square wooden box, and introduced a pulp that we had been endeavoring unsuccessfully to float in an agitation machine. The result was startling in its simplicity and complete success.

Was this air introduced under pressure?

Yes, it was, from a small compressor that we had in the basement, at about two pounds per square inch, as I recollect. We then got busy designing this type of machine. The first machines were circular with a porous brick in the bottom. We soon found that the sand tended to settle on the bottom of the brick and blind it. Then came slow-speed revolving stirrers to keep the sand in suspension. It was soon found that the circular machine was wrong in principle in that it was impossible in this type of machine to avoid a short-circuiting of the tailing to the tailing-discharge, and that the logical type of machine was an elongated box or launder. Out of this developed the machine which I installed eventually at the National Copper plant at Mullan, Idaho, in March 1914.

At this time you were unaware of the British patents obtained by T. J. Hoover in 1910 and also of the experimental work done by Robert S. Towne?

Of course, I knew of Mr. Hoover through his book, and of some of his earlier patents; but at this time, I had never seen and knew nothing of any of his British patents. Of Mr. Towne I had

never heard, and I knew nothing of the researches of either of them.

So you proceeded to design a flotation plant to use this aeration device in the National mill?

Yes. Our experiments with this type of machine in the laboratory on the National ore had been so satisfactory and so conclusive that I decided to take the chances of introducing this type of machine into the National plant. It was a big chance to take, as the whole success of this mill depended upon flotation. Everything proved my judgment correct.

Please state the composition of the ore.

The ore was an extremely hard quartzite, impregnated with chalcopyrite, some chalcocite and bornite, together with iron pyrite. It required grinding to 60-mesh in order properly to liberate the copper mineral. My company designed and erected this plant; we started it in April 1914, and, barring the usual week or two for tuning up, it was a metallurgical success from the start. The operation of the flotation cells exceeded our most sanguine expectations. The plant caused more or less of a sensation and was visited by all the prominent mining and milling engineers in the West.

By this time, you had applied for patent?

Yes. I applied for my first patent in September 1914. This reminds me that I have left out part of my story. In 1911 and 1912, I was consulting mill-engineer for the Inspiration Copper Company and had done all the original test-work in a plant I had built for them at Miami. After the gravity-concentration tests were all completed the question of flotation came up, and they asked me concerning its merits. The Minerals Separation company erected some of their machines in my old test-plant at Miami, and this eventually led to the adoption of flotation as the primary process for Inspiration ores and the abandonment of our old gravity flow-sheet.

Did you also experiment with flotation at the Inspiration?

Yes, later the Inspiration company built a larger and entirely new test-plant on their present mill-site and in this I set up a

complete Callow equipment to go into competition with the M. S. machine.

Did you also experiment with flotation at the Inspiration company's first plant?

Yes, I put in an equipment at the Inspiration test-mill to go into competition with the M. S. machine. Here we fought for about a year with the M. S. and also with the Cole-Bergmann, the Towne, and the Flynn machines—the result of which was that today they are using machines of the type designed by me. I take pleasure in stating that the Inspiration company has recognized my invention and has paid for all the tonnage that they are now putting through their mill.

Meanwhile, what was the National mill doing?

The National mill did excellent work, the recovery running as high as 80%, with a 20-25% copper concentrate. Unfortunately, the mine was not able to furnish sufficient ore for the mill and it shut-down after about a nine months campaign. Since then, it has, at various times, started up, and I believe is again running satisfactorily, using the original flotation plant in every essential respect as we put it in.

Mr. Callow, are you still using canvas as your porous medium for the bottoms of your flotation cells?

Yes, canvas is still the porous medium through which we introduce the air in pneumatic flotation, but owing to the increasing price of canvas and the difficulty of obtaining supplies, and some other weaknesses inherent in this material, there is a tendency to go back to my original porous brick, and some of the mining companies have done a good deal of experimenting with porous bricks made from portland cement and sand, with varying success. We, ourselves, have made some hundreds of experiments in the development of a suitable porous-brick medium, which will soon take definite shape, and which will have much more strength and greater porosity than any other medium now in use.

How do you regard the future for flotation?

I think the future offers tremendous opportunities, both in the way of improvement in the mechanics and also in the

technique of the art. I am satisfied that eventually pneumatic flotation will cover the great bulk of the field. On some complex ores, it may still be necessary to use violent agitation as one of the tools with which to work, but for the majority of ores, the simplicity, efficiency, and low cost of operation will render pneumatic flotation pre-eminent.

Do you expect to see the use of the process extended to ores not now treated by flotation—for instance, will you not say something about the treatment of oxidized ores?

Flotation already covers nearly all classes of ores, not only of the base, but also of the precious, metals. For the treatment of oxidized ores, flotation may find a limited application, and further research may extend this field. At present the sulphide-filming of oxidized ores by the use of a soluble sulphide seems only to be successful on the carbonates of lead and copper, the recoveries on the silicates and oxides being poor. There is an immense field for sulphide-filming if we could once discover how to film the silicates and oxides, but at present this is not known.

In the course of your many experiments and tests, have you obtained any idea of the factor essential to floatability?

With two outstanding exceptions—coal and graphite—all the most easily floatable minerals are sulphides, or, if oxidized, must be coated with an artificial sulphide, which would indicate that sulphur is a necessary constituent, at least, of the surface of the mineral to be floated.

How about scheelite?

We have not been successful with scheelite, or any other unfilmed oxidized minerals, although graphite floats readily; and this exception to the generalization I have just ventured to make leads one to suspect that the floatable properties of a mineral were not solely dependent upon their being sulphides, but upon their lustre. On the other hand, cinnabar, which floats readily, has this sulphur constituent but lacks a metallic lustre.

Native gold and silver are floatable, to a limited extent, but it is difficult to say how much of this is due to their entanglement with the accompanying sulphides and how much to their inherent floatative properties.

Native copper is being floated in the Lake district, when in a finely-divided condition, but, even then, it is difficult to float. There is no doubt, however, that the sulphide minerals are more easily floated, which leaves us in a dilemma as to whether sulphur is a necessary constituent, or merely coincident to a lustrous surface.

Naturally, you must be pleased with the recent decision of the Ninth Circuit Court of Appeals in the Butte & Superior case?

I am, of course, because it confirms the stand that I have always taken in this matter.

By the way, you recognize the great number of possible flotation agents, and I presume that you have tried most of them yourself?

Yes. I have tried every likely flotation agent, and a great many unlikely ones, either in our laboratory in Salt Lake City or at our research department in the Mellon Institute at Pittsburgh. They would number many hundreds. From all those mentioned in the many patents and from others, my opinion is that it is only a matter of time when 'oil' (as we call it) may have to take a second place as a flotation agent. Our experiments and experience with alpha-naphthylamine and other allied synthetic compounds are sufficient to justify this statement. They have upset, in a great measure, many of our previous oil-flotation theories.

Of course, the successful use of plain sea-water for floating the kind of copper ore common along the coast of British Columbia and Alaska upsets all preconceived notions that oil was essential to flotation.

This is quite true, and opens up some interesting speculations. The use of salt is not new to us, as we have used it off and on for a long time. So far as our experiments go, it is restricted to the treatment of pyrrhotite ores and the selection of the copper from the iron minerals. The same can be done with oils or other mixtures, but that is beside your question.

Mr. Callow, does your family include any future mining engineers?

I have three daughters, and one son, who has strong mechanical instincts, and I hope that he will in time join the ranks of the profession, and improve on what I may have done.

THE TESTING OF MEN AND ORES

*If anything were needed to prove that it is character that makes a man, not education, the proof could be found in the diversities of origin and of training from and through which distinguished members of our profession have come on their way to a successful career. Some of them have stepped from scientific colleges or universities as fully equipped as academic study could make them; others have had not even a full course in common schools, and have been compelled to earn their living while their competitors were still undergoing a technical training. The race is not to the swift, but to the persistent; it is not to the smart, but to the wise. Character and circumstance appear to be the two determining factors. The strong character steers amid the shoals of circumstance to the open sea of opportunity; the weak character drifts upon the bank and is wrecked by the first unfavorable wind of adversity. Fortune favors the brave; good luck betides the persevering. Such are the ideas suggested by the interviews with distinguished engineers that we have published and by the one that we publish this week. The subject of our latest interview is widely known for the mechanical devices bearing his name and invented by him; he is also one of those fortunate men who have friends scattered all over that generous kingdom we call the mining world. John M. Callow was born a farmer's son, but the farm was within sound of the North Sea, and to him as to other young Britons from time immemorial the call of the sea was the reveillé of adventure. He had no wish to stay at home on the farm, he wanted to become an engineer, and as an engineer to make a career for himself in the wider world outside the little village in which he was born. When yet a boy he sailed for Australia and visited the old gold-mining districts of Victoria and afterward the newer mines of Queensland, where he had his first experience as a millman. It was a mere taste

*Editorial in the 'Mining and Scientific Press' of August 3, 1918.

of engineering, but the voyage was an education to mind and body. He returned home and completed his training with the local firm of engineers to whom he was apprenticed; but he could not stay in Norfolk; always there was the voice of the sea and the call of the wide spaces. He went to Colorado. Not yet physically strong enough to follow his bent, he applied the art of engineering to the improving of land, and prospered, both in pocket and in health. He left the farm for the drafting-room and soon thereafter demonstrated his intelligence in the selection of a wife. Early in his career he became associated with resourceful men, whose stimulating good-will he was quick to win. A little mining and milling in the mountains of the San Juan added several more pages of useful experience; and then came the larger opportunities for designing mills offered by that energetic mine-promoter, Mr. Samuel Newhouse, and that experienced mine-manager, Mr. Thomas Weir. For these gentlemen Mr. Callow made milling-tests, suggested flow-sheets, and designed plants. Becoming "tired of panning", he built a miniature Wilfley table for making his tests on the Highland Boy ore. That little concentrating table proved so useful that he made copies of it, and sold them, sending them all over the world. On the ground-floor of his ore-testing establishment the original is still to be seen, together with the accessories, from which he developed the idea of a central plant for testing ores as a preliminary to building mills. This plant is now well known, and it is noteworthy that, as he went home to find a wife, so also he chose two school-boy friends to be his partners in business. He designed the cone, the screen, and the tank that bear his name, proving his restless ingenuity, and in later days he introduced the froth-making machine that has made him famous, for wherever flotation is practised there the Callow pneumatic cell is known. It is to be regretted that the exigencies of litigation—not his own legal quarrels, but those of others— prevent him from talking freely on flotation, a branch of metallurgy to which he has made sundry notable contributions. However, the interviewer was able to elicit a few observations, all of which will be found interesting. The way in which he developed his ability as a draftsman to the designing of new [illegible]nes is a tribute to his engineering apprenticeship and also [illegible]ncentration of mind. He could concentrate thought in

his head as he could concentrate chalcocite on his small Wilfley table. As a school-boy he took little part in sports, probably from lack of physical exuberance; instead, he invested his pocket-money in a lathe, to which he devoted the time his fellows gave to cricket. Besides originality, he has the saving grace of being willing to listen to constructive criticism. Impulsive by temperament, he can make enemies, but not nearly so fast as he makes friends; and he holds them, for loyalty is one of his traits; also kindliness. Many are the young men to whom John Callow has given a helping hand, in the way of advice or something more substantial. So say those that know him best. That is worth more than the award of a gold medal.

J. PARKE CHANNING

AN INTERVIEW

Mr. Channing, you are a Columbia man, are you not?

Yes, of the class of '83 of the School of Mines.

I was present when you received the honorary degree of Master of Science at the semi-centennial of the School of Mines in 1914. You are a New Yorker?

Yes, I was born in New York City, in 1863, and graduated from Columbia when I was 20.

What was your first job?

My first job was with Allan Stirling, the inventor of the Stirling water-tube boiler, who was at that time manager of the mines of the Hudson River Ore & Iron Co. at Linlithgo, a few miles below Hudson, in New York State. My work was that of chemist and surveyor, for which I got the munificent sum of $1.50 per day.

Did you remain long at these iron mines?

No. I remained there about three months, and then, through Professor H. S. Munroe of Columbia, I secured a position at Houghton, Michigan, as draftsman and book-keeper for the firm of S. E. Cleaves & Son, manufacturers of mining machinery.

This experience as draftsman, I expect, you found useful in your later career?

Well, to tell the truth, I didn't do very much drafting for the firm. The principal work was that of keeping the accounts, taking orders, collecting bills, and, very frequently, helping in the foundry. We used to cast the heavy shoes that were needed for the steam-stamps; these weighed about 1000 lb. apiece, and were made with a good deal of manganese and cast with a very high 'header'. The peculiar iron from which these shoes were made contracted a great deal in the process of cooling, and the loss

by contraction was supplied by the melted iron from this header. In order to keep the header flowing, it was necessary to pump it up and down with an iron rod. This required the services of nearly every one connected with the institution, including myself. Very frequently in the evening of the casting-day, I would stand for over one-half or three-quarters of an hour with two iron rods in hand, pumping the headers of these shoes.

This gave you some useful experience?

Certainly, I obtained a good deal of practical experience regarding shop-work and mining machinery. After about a year with the firm I was taken on as an assistant to Frank Klepetko, at that time mining engineer to the Tamarack and Osceola mines of the Clark-Bigelow syndicate. The manager or agent, as he was known, was Capt. John Daniell, one of the old-time worthies, really one of the most distinguished and progressive men that has ever operated in the Copper Country. At the time of my employment with Mr. Klepetko, the Tamarack was engaged in sinking its first shaft, and I remember that the Calumet lode was struck one Saturday night; on Sunday morning I went to the office, and Capt. Daniell told me that the night before one of the drill-holes had encountered conglomerate; he had with him the sludge from this drill-hole. He proceeded to van it on a shovel, and thus produced the first copper of the Tamarack mine. I carefully saved the copper from this first vanning, and for a great number of years had it as one of my choicest possessions, but I regret to say that in the turmoil of moving from place to place it has disappeared.

In what year was that?

That must have been in 1885. By the way, there was one little piece of work I did before going with Klepetko, and that was in the autumn of 1884 when I acted as assistant in the Copper Country for A. P. Swineford, Commissioner of Mineral Statistics; I wrote for him that portion of his report covering the copper properties. This, in itself, gave me access to all of the mines of the district.

The Tamarack workings became the deepest metal mine-workings in the world, did they not?

They did, but at the time No. 1 Tamarack shaft was sunk, cutting the lode at 2270 ft., this then deep level was considered a tremendous achievement. The No. 5 shaft eventually reached a depth of 5268 ft. vertical.

Is it likely that the Tamarack mine will be re-opened, having regard to the favorable copper market?

The Tamarack is now owned by the Calumet & Hecla Mining Co., but it is so deep that under ordinary conditions, with the low price of copper, it hardly pays to operate. I have no doubt now, with copper selling at 28 cents,* that conglomerate is being mined from it. Provision is also being made to treat the large accumulation of tailing.

By what process?

Re-grinding, water-concentration, and the new ammonia leaching process, which has been developed by C. H. Benedict. This same process is also being applied to the tailing from the old Calumet & Hecla mine.

Has flotation been used at Calumet?

No. Some experiments have been made, but native copper doesn't lend itself easily to the process, although there is a possibility that it may be adopted for the White Pine mine on ore from the Nonesuch lode, in which native copper is found in a very finely divided form.

Do you recall any interesting incidents of your work with Mr. Klepetko?

During my stay at the Osceola, we concluded to move the stamp-mill from Portage lake, where the tailing was filling the channel, to Torch lake. For that purpose it was necessary to construct a railroad from the mine to the mill, and to build a new mill. This was done during the summer; the mine was shut-down, and the Cornish miners put at work, much to their disgust, at grading the railroad. As it was necessary for them to shovel dirt into wheelbarrows, I remember hearing one of them say: "I'd as soon take a snake by the tail as the 'andles of a wheelbarrow". In the rock-cuts it was interesting to hear them joke about taking a "1-ft. stope off the bottom", and such similar underground

*The date of the interview was September 30, 1916.

phrases. I have no doubt, however, that late in the autumn when the railroad was finished, and the new mill in operation, the miners returned to their work underground with at least five years added to their lives. They went to work on the railroad thin and white, and came back increased in weight and well browned.

When did you leave Calumet?

In the autumn of 1885 I was asked by John Duncan, the assistant superintendent of the Calumet & Hecla, who, together with John Senter and several old-timers, were interested in a concession in Honduras, to visit that country and report upon their properties, and, incidentally, build a steamboat for them on the Ulua river, so as to hold their concession. In October of that year I sailed from New Orleans on the 'City of Dallas' with all the materials for a stern-wheeler steamboat, which was to draw 2½ ft. of water, and a crew of boat-builders. We arrived at Puerto Cortez, and after starting the men at work on the boat, I made my first trip into the interior. The narrow-gauge railroad was running from Puerto Cortez to San Pedro, and from there the trip was made on mule-back. The results of my investigation of the placer deposit were disappointing; the quartz veins were so far from transportation that it was impossible at that time to exploit them profitably; the mahogany concessions proved to be mythical forests; and the amount of freight on the river was not sufficient to keep the boat in commission. I returned in May 1886 to Calumet, and at a meeting of the directors of the company they told me the only fault they had to find with me was that they had not sent me down about a year earlier.

What did you do then?

The new Gogebic range was then opening up, and these same people were interested in options in that district. They sent me over to take charge of them, and I landed in Bessemer, Michigan, in May 1886, when that town was just being carved out of the wilderness, and the streets were axle-deep in mud. Some of the prospecting was unsuccessful, but I succeeded in striking the first ore upon what was later known as the Mikado mine. On the Gogebic it was my good fortune to meet and become associated with another Cornishman, who was as good a friend

and advisor to me as was John Daniell; this man was Joseph Sellwood, at that time manager of the Colby mine. I think that Joseph Sellwood was probably as progressive in the Iron Country as John Daniell had been in the Copper Country, and I have always felt that my career was very much influenced by the good practical advice I got from these two Cornishmen.

I am glad to hear you say that. It does seem to me that the combination of the hereditary mining sagacity of the Cornishman added to the technical education that Columbia gives ought to fit a man for doing the work of mining. What next?

In 1887 Michigan passed her first mine-inspection law, which provided for county mine-inspectors, and I was chosen for the position in Gogebic county. I look back now and consider that I must have had a great deal of assurance to accept a position of such responsibility, considering my limited experience. However, I got as many of the English publications as I could on mine accidents and their prevention, and the reports of Her Majesty's inspectors, and I believe that, for the three years that I filled the position, I did it with benefit to both the miners and the operators.

Your work as an inspector must have given you a good opportunity to gain insight into the character of those operating mines, both above and underground.

It did; not only in my own district, but in that of the other districts, for we mine inspectors exchanged visits. I think that probably more than anything else my position gave me an opportunity to learn the points of view of the laborer himself, so that in later years, when I was put in positions of responsibility, I felt that I could look upon the question from both sides.

You became interested in mining education, did you not?

During my term as Commissioner of Mineral Statistics I had an opportunity of talking with a great many of the miners, and numbers of them expressed to me the wish that they might have some opportunity of studying mining themselves or having their sons educated in mining. Technically-educated mining engineers in the Lake Superior region were then few and far between. I wrote a letter to the 'Marquette Mining Journal' on this subject

and this was seen by J. A. Hubbell, then a member of the State legislature. He spoke to me on the matter and proceeded to get the first appropriation of $50,000 for what is now the Michigan College of Mines at Houghton.

What was your next appointment?

In March 1890 I resigned as Mine Inspector and was made superintendent of the East New York iron mine at Ishpeming. At that time, and also for the last year that I was on the Gogebic range, I did considerable underground work for Messrs. R. D. Irving and C. R. Van Hise, who wrote the now famous Penokee-Gogebic monograph, which was the first American work actually describing the formation of an ore deposit. In 1893 I took charge of a series of explorations for iron ore in northern Michigan; these were conducted by the Chicago, Milwaukee & St. Paul Railway Co. Most of this was in new districts, and while the commercial results amounted to nothing, a great deal of pioneer work was done which, in later years, has been of inestimable value to that portion of the State.

When did you go to the Calumet & Hecla?

In the autumn of 1894 I accepted the position of assistant to S. B. Whiting, who was then the general manager for the Calumet & Hecla Mining Co. I took this position with considerable misgiving, as it was notorious that the Calumet & Hecla mine was an Augean stable, and the task of cleaning it was Herculean. I was young and impulsive, and tried to do too much in too short a time; the consequence was that about the middle of the next year I was summarily dismissed, and I thought that my career was at an end. On the way toward Chicago I stopped at Iron Mountain and spent a day with my old friend, James MacNaughton; he was then the superintendent of the Chapin iron mine. Mr. MacNaughton was born at Calumet and knew the Calumet & Hecla mine well. He encouraged me; told me not to despair; he knew that I was right; that it was not my fault that I had been discharged. A few years later Mr. MacNaughton himself was made manager of the Calumet & Hecla, when the situation, on account of high cost and inefficient work, had become most precarious. With a riper experience than mine, because of his successful management of the large Chapin

mine, with his knowledge of the people at Calumet, with the further advantage of being a native-born son, he made the Calumet & Hecla what it is today. I remember his writing me a letter after he had been there six months, in which he said: "Channing, yesterday I gave the tree a gentle push and 500 rotten apples fell off; what will happen to it when I give it a real shake, you can imagine". By this he meant that 500 unnecessary employees had been let out. I am probably violating no confidence by saying that at the time I went to Calumet the cost per ton of 'rock' treated was about $3.80; at the time Mr. MacNaughton had taken hold, it reached $4.50, and under his regime the cost, in a few years, was reduced to $2.25. I remember that when I went to Calumet I found them laboriously dumping timbers into the skips, sending them down to various levels, and then pulling them out, one at a time. I designed a timber-car, something like a flat car, which could be hitched to the rear of the skip. It had stakes on the sides and carried about 100 pieces of timber. It was no trick to hitch one of these onto the skip, lower it to the level, and dump off the timber; but the old crowd at the mine decided that inventions of this kind were not to be desired and so my skips were relegated to the boneyard. After MacNaughton took over the property, he saw these cars one day and asked what they were, and was told they were the "Channing timber-cars". He said they looked good to him, put them on, and they have been in use ever since. This simply shows the old-time reactionary spirit against which Mr. MacNaughton and myself had to fight.

Were you not, Mr. Channing, later employed by the Calumet & Hecla company to do some special work?

Yes. In 1910 the Calumet & Hecla, which had acquired interests in 11 other Lake Superior copper properties, proposed a consolidation of the 12. It was necessary to have some independent engineer make a report as to the relative value of the properties for this consolidation, and so, 17 years after I had been dismissed from the employ of the company, I was selected to do this work for them. Unfortunately, there was sufficient opposition to the consolidation to prevent its becoming an accomplished fact, but I, on my part, felt that the company had more than re-

deemed any reflection which it might have cast upon me in 1893

So that was your first real set-back. What followed?

As I said, I left Calumet heart-broken, returned to New York, and found nothing to do. I had some money, and so instead of moping in an office, I spent my time in traveling through the various mining districts, seeing what I could see, making notes, and occasionally getting the job of a mine-examination. During the summer of 1895 I helped Professor Peele of Columbia with his summer school of mining in Gilpin county, Colorado, at which time I had the pleasure of first forming your acquaintance, Mr. Editor, and also, incidentally, of meeting F. C. Alsdorf, who afterward brought to me the undeveloped property which is now the Miami mine. In the summer of 1896 I helped Professor Peele again with his mining school, this time at Butte. There I again met Mr. Klepetko, who was manager of the Boston & Montana. He had just finished and was operating the then new reduction works at Great Falls. I became his assistant, and my thanks are due to him for whatever knowledge of practical metallurgy I have acquired. I remained with him for nearly a year and in '97 returned to New York, and did my first consulting work for the old firm of Lewisohn Bros.

And you have been connected with them ever since, I believe?

Yes, for 19 years now. One of the first examinations I made for them was in Arizona, in 1897, when, as a matter of curiosity, I visited the Clifton-Morenci district, where I saw the first 'porphyry copper' mining in the United States. James Colquhoun was then in charge of the Arizona Copper Co. and was sending down the incline to his concentrator ore that looked more like burned lime, with occasional specks and veins of black in it, this being the chalcocite. The three days that I spent in this locality impressed upon me the fact that huge masses of such low-grade material (and in those days we called 3% ore 'low grade') could be made of commercial value. It was either on this trip or the succeeding one that Lewisohn Bros. had me examine the Highland Boy mine, at Bingham. It was owned by the Utah Consolidated Copper Co., and had been floated in London by Samuel Newhouse at 7s. per share. The mine had been started as a gold mine, using the cyanide process, but the

large amount of copper in the ore seriously interfered with cyanidation. In driving one of the lower adits to develop the mine, which at that time showed only oxidized ore, they encountered a large body of sulphide copper ore. Shipments were running as rich as 18% copper, with high values in gold and silver. At the time of my visit a large area of ground was opened on No. 5 adit, the average of my samples being something over 7% copper. At the time the idea of secondary enrichment was vaguely known, and while I recognized that undoubtedly some of this copper was secondary, yet I could see that enough of it was primary to warrant me in assuming reasonable persistence in depth. Lewisohn Bros. had an option on a large block of shares that had not long to run, and my first examination of the mine occupied only about two or three hours. I took no samples, but immediately returned to Salt Lake City and sent them a message in code that it was the best copper mine that I had seen for a long time, and told them to be careful under no conditions to let their option lapse. I then returned to the mine the next day, took my leisure in sampling and making my formal report.

Apparently, Mr. Channing, you believe that a correct impression of the character of a copper mine can be obtained by a mere visit?

In a great many cases a man of experience will be able to pass a quick judgment on a copper mine without the necessity of laborious sampling and assaying. The Lewisohn Bros. took up their option and furnished the money for the building of a smelter, which was done under the supervision of Frank Klepetko. The mine became a large producer, and I am sorry to say that the stock was sky-rocketed from 7s. to £14, a price, however, never warranted by the condition of the mine. It was acquired subsequently by A. C. Burrage, under circumstances that were graphically, though not altogether truthfully, exploited by Thomas W. Lawson in his articles on 'Frenzied Finance'.

When did you go to Tennessee?

In 1898 an English corporation, the Ducktown Copper, Sulphur & Iron Co. was operating the Mary mine at Ducktown.

Tennessee. P. de P. Ricketts acted as their consulting engineer—

That was Professor Ricketts, formerly Professor of Chemistry at Columbia and later of the firm of Ricketts & Banks?

Yes: I called attention to the fact that there were several other mines in the district that it was desirable for them to add to their holdings. They stated that they had sufficient holdings, so Dr. Ricketts took up these options and submitted them to Lewisohn Bros. He expressed the opinion that the ore would run 3% in copper. I was delegated by the Lewisohn Bros. to drill the properties, and during the summer of 1898 this work was done, with Louis D. Huntoon in direct charge of the drilling. The result showed that the ore did not run 3%, but only a trifle over 2½%, and as the price of copper was low, the Lewisohn Bros. abandoned the operation.

But that, I believe, did not end the episode?

No; in the latter part of the next year the late Leonard Lewisohn, who certainly was a man of great sagacity, saw that the turn had come, that the price of copper was going to advance, and after consulting with me as to the possible cost of treatment, took over the properties at Ducktown and organized the Tennessee Copper Co., taking in the Polk County mine, the Burra-Burra mine, and the London mine. The shaft on the Polk County mine was deepened, and two new shafts were started upon the other two. A railroad was built, a roast-yard graded, and a smelter erected on the Ocoee river at what is now known as Copperhill station on the Louisville & Nashville railroad. Predictions were made that it would be impossible to mine and treat this ore at a profit, but I felt that by combining Lake Superior methods of mining with Montana methods of smelting, copper could be produced at 10 cents per pound. The smelter was started in August 1901, my predictions of costs were fulfilled, we began to make a large production, and the property has been a large producer ever since.

You became president of the company, did you not?

On the death of Leonard Lewisohn I became president of the company and remained so for five years.

Do you think it is judicious for the mining engineer of an enterprise to be also president of it? In other words, to what extent do you think it is prudent for an engineer to be intimately concerned in the formulation of a company's policy?

I think that the engineer, if he has business ability, should be put in direct charge of the operations of the property, and should be responsible for its outcome. It is seldom, however, that we can find "the admirable Crichton" who is a mining engineer, a business-man, an executive, and a financial genius, but if he is a good mining engineer, a good executive, and a good business manager, then, if he is associated with good financiers, I know of no better combination.

What were your methods of smelting at Copperhill?

I was seriously tempted to begin with pyrite smelting. First, I consulted my good friend, Klepetko; he communicated with Robert Sticht; they both advised me that on a new property it was not desirable to make too many innovations, so we fortunately started with a method of smelting heap-roasted ore in blast-furnaces. After we had been running about two years, W. H. Freeland, then manager of the Ducktown Copper, Sulphur & Iron Co., and now a resident of San Rafael, in your State, began the experiment of treating his ore pyritically. He froze furnace after furnace, tried hot blast and cold blast, and finally, after a year's patient experimenting, succeeded in smelting the ore successfully by the heat of its own combustion, with the addition of barren quartz and a very small amount of coke. He soon changed from roasted-ore smelting to pyrite smelting. I was glad to profit by his experience and follow in his wake. We altered the Tennessee plant so as to perform pyrite smelting without making any changes whatever in the furnace.

Was that when the smoke troubles began?

Yes, the farmers of Georgia began to protest, the boundary of that State being only about 1000 ft. away, and the prevailing wind being from the north, it blew the smoke from the smelter in Tennessee across the boundary into Georgia. I had always felt, even from the very beginning, that there were possibilities

of utilizing the sulphur of the Ducktown ores, so we started experimenting by closing up the top of the furnace, preventing the entrance of 'false air' as it is called, and started making sulphur dioxide determinations of the gases. Much to our surprise, they ran 6% and upward. The question then arose, should we use the 'chamber' process or the newer 'contact' process. We got into communication with the Badischer Anilin und Soda Fabrik, in Germany, who sent over a corps of engineers and chemists to investigate our conditions. They were very frank in their report, and told us that our gas was so rich that it was unnecessary for us to consider their contact process, and that we would be perfectly safe in using the old-fashioned chamber process. On the strength of my recommendations the directors of our company authorized an expenditure of $1,000,000 for the building of a sulphuric-acid plant. I called into consultation the late F. J. Falding, and between the two of us the plant was started and put into operation. We soon started making 60° B. acid, but, of course, in a new process of this kind, ran against innumerable difficulties in the way of eliminating flue-dust, and in getting the proper nitration. We succeeded, however, in getting the plant up to a capacity of 300 tons of acid per day.

To whom did you sell the acid?

To fertilizer manufacturers in Georgia and neighboring regions. A little later we made a contract with a new concern known as the International Agricultural Co. for all of our product. Later still the Lewisohn Bros. sold out, the enterprise passing into other hands. This was in 1908. Utley Wedge then took up the work where I left it. He has made many improvements, and is at present producing concentrated acid and has also doubled the size of the plant. The plant that I built has now been keyed up to a production of 600 tons of acid per day, and presumably in a year the Tennessee Copper Co. will be producing 1200 tons of 60° acid per day from fumes that ten years ago were not only a waste, but a nuisance.

Of course, the War has created an abnormal demand for acid?

It has, and, of course, it takes time to build acid plants, which is the reason that the Tennessee Copper Co. has such a good market for its concentrated acid today.

When you left the Tennessee Copper Co., Mr. Channing, if I remember correctly, you formed the General Development Co.

That is not exactly right. We formed the General Development Co. in 1906, some three years before I gave up the active management of the Tennessee Copper Co. The General Development Co. was organized for the purpose of developing prospects and taking hold of partly developed mines, with a capitalization of $2,500,000, later increased to $3,000,000, of which only $1,000,000 was paid in cash. Up to date it has paid about $1,800,000 in cash dividends and has assets of a value of practically $5,000,000. What led to the formation of this company was that in 1904 Messrs. Requa, Bradley, and Mackenzie had developed a very promising copper prospect near Ely, Nevada, this being one of the first so-called porphyry deposits, that is, a low-grade mass of silicious rock in which chalcocite is sparingly disseminated. In the winter of 1904 they were ready to raise the necessary money to develop and equip the property, build a railroad, and erect reduction works. The raising of this money was entrusted to a large banking-house in New York whose senior partner assured them that he would have no difficulty in obtaining the necessary funds in France. He went to Paris, with most excellent detailed reports by Requa, Bradley, and Mackenzie, but when he confronted the French engineers with the proposition of making money from a deposit that ran 2¾% copper, they laughed at him, and refused to consider it. It simply showed that they were not up-to-date, for they did not realize what could be done. So, in the summer of 1905, I was asked by the firm of S. D. Loring & Co., of Boston, to make an examination and report upon the property of the Nevada Consolidated Copper Co. It was here that my three days spent at Clifton, Arizona, in 1897, were of incalculable value to me, for I saw that with Lake Superior methods of mining and Arizona Copper Company methods of concentrating, plus the smelting practice of the Boston-Montana and the Utah Consolidated, the property would be a successful venture. On the strength of my report, Messrs. Hayden, Stone & Co. and other people took stock, I believe, in the neighborhood of $4 per share. A block of these shares was offered to Adolph Lewishon, who declined to take them. Later

on, seeing the shares advance, he approached me and suggested the organization of the General Development Co., with myself as consulting engineer.

When did you find the Miami?

After the General Development Co. was started, we spent considerable money at Butte and other places without result, but in December of 1906, when visiting Globe, I ran across my friend, F. C. Alsdorf, whom I had met in Gilpin county, Colorado, in 1895. He called my attention to some ground six miles west of Globe, which, in his experience of the Clifton district, he thought might be underlain by a copper deposit. I went over the ground with him, and looking at it in the light of my Clifton experience, and of experience with the Nevada Consolidated at Ely, I agreed with him. The General Development Co. took over the property and began development work in January 1907, and in May struck ore at the No. 2 Red Rock shaft, at a depth of 220 feet.

What was the ore?

The copper was in the form of chalcocite, disseminated through schist, and ran about 3% copper. Although the Miami and Ray mines are both in schist, still the term 'porphyry' has become so well established that the name is used notwithstanding that in some cases the ore is in real porphyry and in some cases in schist. The Miami Copper Co. was floated in the spring of 1908 at $5 per share, the company being organized for 600,000 shares. Of these 300,000 were issued for the property to the General Development Co., and the first 200,000 were sold at $5 per share to provide initial working capital. Later, as the mine developed and the ore-reserves increased, the remaining 100,000 shares were sold at $10 per share. Afterward the capital was increased; and 150,000 shares were issued at about $17 per share; it consists now of approximately 750,000 shares issued, and the total initial cash invested in development and equipment amounts to $4,500,000, so that the original purchase price becomes relatively insignificant as compared with the cost of development and equipment.

So the price of the property was small compared with the cost of making it a mine?

No, that is not exactly right. If you consider the bare cost of this undeveloped property to the General Development Co., then Yes. The General Development Co. took the risk of prospecting and had lost money in previous ventures leading up to this one, but it sold the developed Miami property to the Miami Copper Co. for, at that time, a consideration that was $1,500,000, namely, 300,000 shares at $5 per share.

This venture has proved a complete success?

It has. The Miami Copper Co. is now producing over 4,500,000 lb. of copper per month at a cost of under 9 cents per pound, and it is estimated that it has ample ore resources to maintain this output for many years.

Mr. Channing, I believe your company is a defendant in a case brought by the Minerals Separation for infringement of patent rights governing the oil-flotation process.

Yes, this is a fact. The case was tried in the spring of 1915 in the U. S. Circuit Court at Wilmington, Delaware. No decision has as yet been rendered.

I take it that you are impressed with the great usefulness of the flotation process?

Yes, I am, but in view of the fact that the matter is in Court, I do not care to discuss it.

You consider mining engineering a good profession for the American boy?

I do, but I doubt whether the possible prizes are as great as they were at the time that I graduated. Still, the tendency at present is to demand more and more that technical graduates be employed at the mines, even in such a subordinate position as shift-boss, so that there always is an opportunity for a capable man to start at the bottom and work his way up. I have tried, year after year, to impress upon the graduates of mining schools that they must not think that when they get their degree they are finished engineers. They must realize that they have only the ground-work for learning the business of mining and that it is as necessary to work in the mine or reduction works to learn the business of mining as it is to work in a grocery store to learn the grocery business, or in a bank to learn banking.

Then I shall ask you whether you agree with me in considering that the American mining engineer as a rule does not get enough underground experience; in other words, that he shines most at surface, and appears to have a dislike of work underground?

No, I would not say so. I think the younger graduates who are coming out are just as ready to go underground as they are to go into the mill or smelter, and there have been such refinements in milling and smelting that the great economies of the last ten years and probably for many years to come are going to be in mining methods; there's where the great improvement is to be achieved.

What prospects can you see for the acquirement of additional skill in the finding of ore, which is, after all, the first step in mining?

The easily recognizable metal deposits of the United States probably have all been discovered. There undoubtedly remain a great many, not only of copper, but of other metals, in which a careful study of the surface conditions is required in order to lead to correct inferences. Take, for example, the question of oil. I was impressed, some four years ago, on my visit to Russia, to find that there was little 'wild-catting' or venturesome prospecting in Russia, such as there is in the United States. If there was any supposition that a certain district contained oil, possibly a year or six months was spent by trained geologists in thoroughly studying the geology, in putting down short drill-holes to determine the formation, to establish the dome or the anticline, and not until all this work had been done carefully was the first deep drill-hole started. The result has been that in Russia there are probably fewer dry holes than in the United States.

In other words, careful scientific investigation is recognized now as a first step in intelligent mining?

It is. The days of the rich deposit that anyone could exploit are over, and we are reduced to the necessity of extracting our metals from material that in the past was passed over as waste rock. To make material of this kind pay one must have a large deposit and careful geological work must be done in connection with its development. The method of mining and the method

of treatment to be adopted must be the subjects of careful study and experimentation, and after the work is under way one cannot let well enough alone but must be ever on the alert to improve extraction and reduce costs.

A SUCCESSFUL ENGINEER

*On another page we publish an interview with Mr. J. Parke Channing. This, like similar autobiographical records, conveys several lessons, more particularly to the younger members of the profession. To those experienced in mining the interview does not need to be recommended, for Mr. Channing's reputation is such that anything he says is sure to provoke keen interest, especially when he has been driven by the editor into a reminiscent mood. The story of this engineer's life is an endorsement of a special training. Mr. Channing is a representative product of the Columbia School of Mines. Having known a number of the men in his class at Columbia and in the classes immediately preceding or following that of '83, we have concluded that the 'early eighties' was a good time for the incubation of talent at our premier mining school. In analyzing the causes contributing to the professional success of the Columbia men of that time, more especially, we have decided that it was due to two factors: First, they came from the older mercantile communities of New England, from New York or Boston, from among families endowed with keen wits and business acumen. In later years the Columbia Mines students have been recruited from all over the continent, but thirty years ago the attendance was predominantly from the Eastern seaboard. We are more certain about the second factor: an excellent schooling in mathematics. "Do ye ken Van Am?" Undoubtedly the thorough mathematical teaching given to two generations of graduates by J. H. Van Amringe played a notable part in giving the United States a number of highly efficient men, in every walk of life, particularly engineering. For instance, in the latest victim to our interviewing campaign, we detect the ability to employ mental arithmetic, skill in selecting salient figures and making correct inferences therefrom, and above all, that constructive imagination whereby the

*Editorial in the 'Mining and Scientific Press' of September 30, 1916.

engineer can foresee his work before he starts to do it. Mr. Channing is an assiduous collector of information on technical subjects, and he is a willing exchanger. He has the co-operative trait, which blesseth him that giveth no less than him that receiveth. We have been told by some friends of his, with whom he pioneered the first automobile into the Nevada desert, that he has the quality of persistence and indubitable skill as a mechanician. On that memorable occasion—12 years ago—he exhibited the marks of a 'good sport', under trying conditions. We know that he has the sense of humor, without which life would be a dreary desert, for he tells many Cornish stories that would convince anyone not born at Camborne or Redruth. But he learned more than this from his Cornish friends in the copper and iron regions. He imbibed some of their inherited sense of mining when in his younger days he consorted with such worthies as John Daniell and Joseph Sellwood; and yet he escaped the reactionary conservatism of the Cousin Jack, as is indicated by his effort to get the Calumet & Hecla staff out of a weary rut. That was a striking episode in his career. We sympathize heartily. His criticism, then and now, was thoroughly sound. It is delightful to see the young man whom those Bourbons of mining denounced because he tried to introduce progressive methods, able now, by reason of success and reputation. to pay them his compliments. It appeals to our sense of justice. Since the date of our interview, the Calumet & Hecla deal for the purchase of the Tamarack has been declared off. Next we come to his participation in copper mining in Utah, Nevada, and Arizona. Each of these episodes proves the value of cumulative observation and experience. Acquaintance with copper deposits at Butte and Clifton permitted Mr. Channing to come to a quick decision as to the value of the Highland Boy mine. In the Tennessee undertaking, he drew upon his Lake Superior experience of mining and his Montana experience of smelting so as to incubate a highly profitable enterprise. Again, the Nevada Consolidated story shows how the three days spent at Clifton, with its hint as to how a disseminated copper deposit could be exploited to advantage, paved the way for another success. Incidentally, it makes a mining engineer feel old to recall the days when a 2 or 3% copper orebody made capitalists sneeze. Only a dozen years have passed, but a great change has

come over the face of the copper industry. Finally, we have the Miami story. That suggests that if you throw your bread on the waters it may return to you buttered after many days. In short, a small incident may be fruitful of big results. Above everything, it proves the usefulness of a knowledge of men: of becoming acquainted with as many of the personnel of mining as possible. Thus the chance meeting with Mr. Alsdorf in 1885 gave Mr. Channing the opportunity 11 years later to develop and exploit the Miami mine. He made fine use of it. The Miami business likewise illustrates the successful working of an exploration company, and the manner in which, under proper guidance, such speculative ventures can be made highly remunerative. The reader will find that the interview closes with interesting replies to some of our leading questions. The American mining engineer nowadays, we believe, spends more time underground than he used to do twenty or thirty years ago. We agree with Mr. Channing that it is there—in the finding and breaking of ore—that the best scope for economical betterment is to be found. Yet, we query whether metallurgical ingenuity has been exhausted. The revolution made by the flotation process is too recent for the belief that we have reached the limit of perfection in that art. As to the finding of ore, all we know is small indeed when compared with the knowledge we lack on this vital subject. There is also the basic problem of human efficiency and the adjustment of the human relation between employer and employee. In this department Mr. Channing takes a keen interest. He has contributed, in many ways, to the campaign for 'welfare'. In matters appertaining to his profession, he has proved public-spirited. For instance, he was a founder of the Mining & Metallurgical Society of America, an organization that, like the Progressive party, was destined to discipline the older Institute rather than lead its members to see a higher light. Mr. Channing has taken part in the efforts to reform the mining law. In short, he has shown how a mining engineer can be a highly specialized instrument of industry and also a good citizen. He has justified his education.

ARTHUR DE WINT FOOTE

AN INTERVIEW

Mr. Foote, you come of old American stock?

Yes, for eight generations; my ancestors came from Yorkshire in 1630.

Where were you born?

At Guilford, Connecticut, in 1849.

Was your father interested in mining?

No, my people were farmers and soldiers for generations.

That explains your interest in irrigation, and in engineering as applied to the improvement of farms.

I suppose it does; I was interested as a boy in a drainage scheme we had at home.

What was your early education?

Private school and high-school and a short time at the Sheffield Scientific School at Yale in the class of '69, which I left in 1868. My eyes gave out, so I had to stop studying. Then I went to Florida to grow oranges. After a year or two I went back to New York and got my eyes back. The next winter I was in the West Indies. Then I returned to New York and worked in the Atlantic Dock iron-works, in Brooklyn. Later, I was over a year at Washington, laying asphaltum pavements. During this time I was studying more or less on engineering lines. In the fall of 1873 I came to San Francisco.

What brought you here?

I was looking for something to do, and at that time San Francisco was lively.

Did you get a job soon?

Yes; I went up to Virginia City, Nevada, as assistant engineer on the Sutro tunnel.

Under Adolf Sutro?

Yes. Wederkind was chief engineer. He was a Dane who had run the lines for the Hoosac tunnel and came out to the Sutro tunnel as engineer several months after I got there.

Do you recall your impressions of the Comstock and Virginia City?

I had a letter of introduction from James D. Hague to Isaac Requa, the father of Mark L. Requa. He was very civil to me and showed me around. I remember being much impressed by the Cornish pump in the old Chollar-Potosi shaft. I met Ross E. Browne there at that time.

Which impressed you most, Ross Browne or the Cornish pump?

I think Mr. Browne made the most lasting impression. He worked with me on the tunnel some of the time before Wederkind came out. He has been a good friend of mine ever since. I left there in 1874. Sutro fired me. We had struck a flood of water in shaft No. 2 of the tunnel and were drowned out.

Why were you drowned out?

We had to run the pumps so fast that the steam-pipe heated the shaft until it became impossible for men to work. Sutro came to the office, fuming and swearing, whereupon I told him that we had not been 'drowned out' but we had been 'burned out'. He did not like it, so we parted company. I did not then know that he had put in the steam-pumps against the advice of everybody who understood the subject, because he could buy them for stock in the tunnel company. At that time the only kind of pump that would have served our purpose was the Cornish pump. Today, of course, under similar circumstances, we would have used electric pumps. It might be worth while, as a matter of record, to mention that while at the tunnel I helped J. B. Pitchford, who was master mechanic, put up the first air-compressor installed in the West. In fact, there had been but two in the whole coun- before that: one at the Hoosac tunnel and one at a Delaware ackawanna railroad tunnel.

What did you do next?

I went up on the Eldorado canal under F. A. Bishop, on the south fork of the American river. It supplied water to the hydraulic mines around Placerville. I remained there only a matter of eight months. Then I went down on the Southern Pacific railroad to Tehachapi, where I was under William Hood, chief engineer of the Southern Pacific. He was very kind to me and we have been friends ever since. I got tired of the desert country and got back to underground work at New Almaden.

Who was in charge of the New Almaden at that time?

J. B. Randol.

Who was in charge of the engineering staff?

No one but myself. Hamilton Smith came down to look over my work on a difficult piece of surveying, and thereby I became pleasantly acquainted with him, and through him with Henry C. Perkins. I stayed there some three years, and while there, in 1876, I was married to Mary Hallock.

Did you live in the old 'casa'? I remember making a visit there when W. H. Landers was manager in 1917.

No, we lived on the hill; I fixed up a little cabin there. Both of us enjoyed it. My work was absorbing; some of it was quite difficult, and the Mexican element was extremely interesting to my wife. Our son was born there. He is now general manager of the North Star mines, at Grass Valley.

Why did you leave?

Randol and I did not agree.

On technical matters?

No, on general principles. I resigned and went up to Deadwood, South Dakota, where I worked as engineer under Sam McMaster, superintendent of the Homestake. I opened an office on my own account, but most of my work was done for the Homestake Mining Company. The owner, George Hearst, who

was in partnership with Haggin and Tevis, was living there at that time.

Was Hearst a good miner?

His principal business was lawsuits. He always claimed he did not know anything about mining, and refused to act on his own judgment. He said, if he went to a dump he would be sure to pick up the only piece of good ore that was on it. He employed Henry Janin, Louis Janin, and James D. Hague. He himself was dirty, slovenly, and extremely vulgar.

Was there anything in your work at the Homestake of special technical interest?

Well, there was only one point of particular technical interest; that was whether the Homestake and the Old Abe veins came together in depth; but the mines were not opened sufficiently to warrant an opinion. It was thought finally that they would come to gether, so Hearst bought out the other parties, after trying to beat them in a lawsuit. I was not sorry to leave Deadwood, in '78, to go to Leadville.

Yes, I know you were at Leadville, because I read 'The Led Horse Claim', Mrs. Foote's book, about 35 years ago, and I still recall the charm of it. What took you to Leadville?

My first job was on the Iron Silver suit, as an expert. That used up several months. I established an office there and was afterward in charge of the Adelaide and several other small mines.

What was the mine that figures in 'The Led Horse Claim'? As I recall, the story dealt with a lawsuit and trespassing that culminated in fighting underground at the boundaries of two conflicting properties.

The foundation of the story was the suit between the Adelaide and the Argentine.

It is generally supposed that the hero was typified by Ferdinand Van Zant?

No, he was a friend of ours and he was my clerk at that ıe, but a great many incidents in the story were imaginary. It

was a picturesque case. When the fellows on the other side broke through below, they drove our men out. Steve Fleming grabbed his Winchester, threw his leg around the rope—a wire rope—and went down, hand over hand. He got to the bottom and ordered them out. They could not see him, of course, but they could hear the click of his rifle—not to mention the language that he used, suitable to the occasion—they went.

Who, among mining engineers, were at Leadville at that time?

Most of them used to come around to us: Clarence King, Rossiter Raymond, S. F. Emmons, James D. Hague, R. E. Booraem, R. W. Emmerson, and many others. Tom Walsh, of Camp Bird fame, was keeping a hotel in Leadville. When I first arrived, I could not get a room, so he took me in most kindly. I had known him at Deadwood.

Was he a carpenter at Deadwood?

No, I think he kept a restaurant there. It was a very pleasant summer in many ways, because Emmons had his camp near our cabin on the outskirts of the town, and we used to have delightful meetings with him and Clarence King, Hague, Raymond, and other men of high character, coming and going. Dr. Raymond wrote a poem on the cabin and sent it back to us. I remember twenty years afterward going to his office in New York, and as soon as he saw me enter the room he started to quote this poem of his, 'The Little Log Cabin by the Ditch'.

Can you mention some technical recollections?

Yes, I would mention the fact that at this time James B. Grant, afterward of the Omaha & Grant Smelting Company, and Governor of Colorado, did the first direct smelting of galena without roasting in a blast-furnace—a water-jacketed furnace. Those of us who were in Leadville at that time took a keen interest in the experiment.

How long were you at Leadville?

I was there over two years. Mrs. Foote enjoyed it more than I did, because it was such a contrast to her previous life on the Hudson river and in New York City. She began to write while at Leadville, and her first story was the one that you have

already mentioned. It encouragd her to keep on. Before that she had been an illustrator for magazines in New York. My health broke down, owing to the high altitude, which affected my nerves, and I went East for a while. That winter I went to Mexico and stayed down there for several months.

Where?

For a time I was at Morelia in the State of Michoacan. The trip did me lots of good, and on my return I went into the Wood River country, Idaho.

What mines?

I examined several mines, and finally opened up a prospect called the Wolftone.

Did you name it after the mine at Leadville?

No, it was probably named after the Irish leader. I stayed there until the beginning of the next winter, and while there I became interested in an irrigation project on the Boisé river in the Snake River valley. The land lies between the Boisé and the Snake, forming a peninsula. I took up water-rights on the Boisé river and made the surveys for a canal to serve some 300,000 acres of land.

On your own account?

I was doing it on behalf of myself and some friends. We organized a company later and called it the Idaho Mining & Irrigation Company. My habits as a miner led me to prospect the bars on the Snake river and to add the word 'mining' to the name of our company.

Did you find anything?

Yes, I found a large area of ground that would pan from 50 cents to a dollar per yard. Eventually, when we got a small canal built and water on the ground, we washed it as they do

pointing. We did not work long. That was just a year or two before the discovery made by MacArthur and Forrest.

But if the gravel contained from 50 cents to a dollar per yard, surely it will pay to work today?

I presume that it would; but at that time we gave our chief attention to the irrigation work. I was there some twelve years and had great difficulty in getting money to build the canal, but finally built a portion of it. Our directors had trouble among themselves, and the enterprise was abandoned. The canal has since been built by the Government. There was never much publicity about it, though it is the largest irrigation canal in America or Europe, having a capacity of ever 4000 cubic feet per second; and the Arrow Rock dam, which forms a huge storage reservoir for it, is the highest dam in the world. During that time I was engaged for a couple of years or more on Government work—the first Government irrigation survey in the United States. I had charge of the Snake River division under Major Powell, director of the U. S. Geological Survey. Those years were extremely interesting, with two or three parties running canal-lines on the Snake River desert, preliminary surveys for the irrigation of several million acres, hunting the Grand Teton range for reservoir sites on both forks of the Snake river, through Jackson's Hole, up to the Yellowstone and Henry's lakes.

So then you had to abandon this Boisé project, and you returned to mining?

Mining or quarrying. In 1893 I went to Lower California to open up an onyx deposit, in which Emmons was much interested. In fact, I went down there with him. There was a big mass there of the most beautiful rock you can imagine, but it was 75 miles from the coast. I built the wagon-roads and arranged for putting the material on board ship. Then the panic came on and the enterprise was abandoned. From there, I came up to San Diego, and Hague telegraphed me to come to Grass Valley. On my arrival he told me of some of his plans for the North Star mine. He told me that he was going to open up the Rocky Bar mine on Massachusetts hill—I mean the one in which the Watts made their money. It was rumored that there

was a good deal of water to be encountered, and Hague wanted me to go and see what few electric plants there were then in the West, so I went to the Fremont mine at Amador City and saw their electric pumping equipment. I was to have gone to Bodie, but I did not go. It was just after the Bodie electric line had been completed. But I went to the Calumet & Hecla in Michigan. They had just put in two sets of pumps having a 1600-ft. lift each. I stayed there for a week and learned all I could about them. In January 1895 I came to Grass Valley to open up the [illegible] mines for Hague, who represented what is now the North Star Mines Company.

The company was in [illegible] proprietary.

Yes, we had [illegible] shareholders. The Agnews and [illegible] of New York, the Phelps Dodge people, including James Douglas [illegible] Morgan was one of the stockholders, also Balfour [illegible]. Hague himself had a large interest.

[illegible] mine. Emile Rector [illegible] That must have been in [illegible] comparing [illegible] county. [illegible] Grass Valley was on [illegible] Empire [illegible] on my return [illegible] most intelligent mining [illegible] Grass Valley. [illegible] mine. [illegible] must have [illegible] during your residence [illegible]

Yes, [illegible] pleasure [illegible] have them come there.

[illegible] North Star [illegible]

[illegible] electric power for [illegible] power was not [illegible]

compressed-air plant to do our pumping, hoisting, and drilling.

What sort of a plant did you erect?

We were getting our power from water. We bought water, delivered to us at the top of the hill over 2½ miles away, and we let that water down in a pipe to the lowest point of our land and applied it to Pelton water-wheels. Our ditch gave us an 800-ft. head of water, and that, by the use of large water-wheels, enabled us to employ direct-acting compressors.

Of what make were they?

The first two were designed by Edward A. Rix of San Francisco and were very successful. Later we put in two others of our own design.

How long did it take to unwater the old mine?

The mine did not make a great amount of water: four to five hundred gallons a minute. It took us about four months, after we started the pumps, to get to the bottom. That was late in 1896.

Then you began to explore the old workings and open up new ground? Were you put in charge?

After I got the machinery all in, I was appointed superintendent. That was in June 1896. We began sinking, and found that the old shaft was vertical for about 240 ft.; then it went off askew at a flat angle.

So that it was not usable?

Well, I made it work by putting in a vertical curve, as well as a horizontal curve to get into the old incline and then I was obliged to put another horizontal curve into that shaft to get down at right-angles to the vein. It was about as straight as a dog's hind leg. We found a nice body of ore on the 1300 level. We also found a good body of ore up above where the Watts had taken out their bonanza.

What level?

That was above the old workings, probably 200 to 250 ft. from the surface. As we went down, the vein became larger but very poor, and it continued to flatten, so that the conditions

became most discouraging. We stopped and abandoned the mine.

That was in?

In 1899.

Had you made any profit over the cost of equipment?

Yes, we had taken out enough to pay for all our trouble and a little more. We took out about $800,000 worth of gold. In the meantime we started a new vertical shaft to tap the North Star vein at the 40 level—that is, as measured on the dip of the vein. The shaft cut the vein at 1600 ft. below the surface in April 1902.

Did you find good ore?

Yes; we found, right at the bottom of the shaft, a bunch of fair ore. The quartz from the first blast, as it came up, showed little bits of gold in almost every piece. It probably assayed about $20—an ounce—per ton. Then we cut our station and commenced drifting and put up a raise to reach the bottom of the old shaft. Of course, we encountered a great deal of water. In driving at the 40 level and putting up this raise we often had to plug up the holes to keep the water from drowning the pumps.

But I presume that the pressure was greatly relaxed as the water-plane was lowered?

I presume so. After a year or so this flow of water almost ceased. We extended the 40th level, and then the 37th, and then others in succession. The 37th was the richest level in the mine.

By "rich" what do you mean in terms of feet and dollars?

There was over 2000 ft. on that level that would average $15 for a width of 2½ ft, in the mill. Near the shaft there was one bunch from which we took out $16,000 from ore that was so rich that none of it went to the mill. We crushed it up in the assay-office and put it into the crucible to be melted. It was great stuff, I tell you.

The mine has had no set-back since then?

Not until the War raised the prices of everything that we

had to buy, and did not raise the price of our product, namely, the gold.

What has been the output of the North Star since you have been connected with it?

I will have to refer to the records for that. They show about 1,600,000 tons averaging $11.35 per ton, making a gross value of $18,000,000, from which about five millions have been paid in dividends.

How is the bottom of the mine?

On the 6300 level the North Star meets what we call the 'X' vein, that is to say, a vein coming down from the east at a dip of about 40 degrees. Whether the North Star vein goes through, we don't know yet. Apparently it does not on the south side of the shaft. Meanwhile, the 'X' vein is going down strongly, dipping west, and shows a good width of milling ore scattered in a wide lode.

What is the vertical depth of the 6300-ft. level?

The dip averages 24°, so that level is 2500 ft. below the surface or 100 ft. below sea-level.

Are you doing any work below the 6300?

No. When we shut-down last winter, we stopped all the work on the 63, and now are doing development work and a little stoping on what we call the 'A' vein on the 34, 40, and 47 levels. This 'A' vein connects with the North Star vein between the 40 and 47 levels.

You say that you shut-down last winter. Why?

The mine was not paying owing to the fact that about one-third of the men would not do a fair day's work and would not allow the others to do so. Therefore, we discharged 250 men, retaining 110, doing just stoping enough to pay our overhead expenses and taxes, and a large amount of development work on the 'A' vein. These 110 men are doing more than two-thirds of the work done previously by the crew of 360.

The men that you have retained, I presume, have homes in Grass Valley?

Yes; they are old men who have been with us for years. They are mostly the sons of Cornishmen who came to Grass Valley in the early days. All the old fellows are pretty well gone.

What do you think of the proposal to levy a tax on manufactured gold under the McFadden Bill? Do you think it will help gold mining in California?

I think it might help gold mining, but I object to it as being special legislation and thus giving an excuse for other special legislation that would injure us about as much as the proposed law might help us.

Are you using flotation in your mill?

No. We made a pretty careful investigation to ascertain if it would be advantageous to us, but we found that the amount we might save would be very nearly eaten up by the royatly and would require a considerable investment. It was a question whether the profit would be sufficient to pay for the investment. The terms of the contract we could get from the Minerals Separation Company disgusted us so much that we told them to go to hell.

Mr. Foote, your son has followed in your footsteps?

Yes; he graduated as civil engineer from the 'Tech.' at Boston in '99 and came as my assistant at the mine in 1904. In 1912 we made him general superintendent, and in 1915 he was made general manager. Meanwhile, I was semi-retired as consulting engineer for the company.

By the way, you had an interesting experience in the Tightner mine, did you not?

We had an experience that was delightful for a time. It was rather interesting. Driving north on the vein, we struck a bunch of quartz about 30 ft. wide and perhaps 100 ft. long. We stoped up on the foot-wall, getting indications of gold; in fact, we milled about 5000 tons, which went $2.49 per ton. Then, in putting up a raise from the stope, we ran into coarse gold, and worked to the hanging over the former stope of poor quartz, taking out $750,000 in gold in a space less than 100 ft.

square. Some of it was so rich that we had to cut it up with chisels to get it to the mill.

Did you send it to a stamp-mill?

Yes, we put it under the stamps in order to remove the barren quartz, and then milled it.

That is, you used the stamp-mill as a crusher and not as an amalgamator?

Exactly.

I presume that the so-called barren quartz was good enough to be re-treated?

It went right on over the amalgamating-plates in the regular way.

Well, that must have been delightful, but did it happen again?

Not in such a large amount, but we found numerous bodies that yielded from $75,000 to $100,000 in the course of three years.

Did this gold occur above the water-level, or the limit of oxidation?

That is pretty hard to answer, because the apex of the vein is covered by 1000 ft. of lava. The Middle Yuba river near-by is at a level 2000 ft. below the horizon at which we found this gold.

Did you find the outcrop of the vein in the bedrock of the old alluvial channel?

That was where the old miners discovered it and told H. L. Johnson about it, and he opened the old tunnel and found it. That was the origin of the Tightner mine.

How much has the Tightner produced?

Under our management, it has produced about $1,700,000, and about $400,000 more for others.

Do you consider mining engineering a good profession for the young men of this generation?

Yes, it is a fine occupation. The mining engineer's life is as interesting as that of a civil engineer, and there is probably

more money in it, but the civil engineer or the railroad engineer or the hydraulic engineer has a broader education and a broader scope than the mining engineer.

Have you any suggestion for improving mining education?

Professional education, I suppose you mean. Prof. Christy used to ask me that question and when I suggested reading and writing he seemed disappointed until I explained that by 'reading' I meant reading good literature, historical mining, and geology until the student acquired something of a vocabulary and the proper forms of language, and by 'writing' I meant a cultivated hand-writing, and using words intelligently so as to convey ideas clearly with fine distinctions. When a man can do that he has advanced far in his profession.

Have you any particular ideas for the betterment of industrial relations, that is to say, for improving the relations of employer to employee in mining enterprises?

My idea is that the personal equation is everything. The great difficulty is that when you get a large number of men under one management you obliterate that personal equation and so render the relations unhuman. I think the remedy is coming by means of the shop committees, as they call them in England, or grievance committees—an unfortunate name—more properly welfare committees, composed of one man from each gang of workmen to meet with a special representative of the management freely and without prejudice at any and all times. Any serious matter that cannot be arranged by him is brought to the superintendent, and if not then fixed up, is brought before a Board of Conciliation composed of employees and officers in a proper proportion. This welfare man must have the special talent for spreading his personal equation of kindliness and reasonableness through all the working force. This man will be difficult to find, but the position is next in importance to that of the manager and should be treated accordingly.

What do you think about the proposed Department of Public Works to include all the engineering functions of the Federal government?

I think such a Department would save millions of dollars every year and get more, much more, useful work done than is

done now. Such a Department organized by and under the direction of Herbert Hoover, taking the place of the Interior Department, would prove so economical and efficient that soon the people would be demanding that all engineering work should be done under it.

What do you consider the prospects of further gold discoveries in the United States?

If you mean absolutely new discoveries, like Cripple Creek, I imagine few are to be made. If you mean new discoveries in small mines and prospect-holes now lying idle or being held by annual assessment work, I think there are great numbers to be made. When gold again reaches its normal value, gold mining will revive and our production will increase and continue for many years beyond our ken. It probably will not be as spectacular as in the past, neither will it be as uncertain. Much has been learned about gold mining, even in the last 25 years, and it seems to me that the future mining will become more and more a manufacturing business managed by trained men, who will take only reasonable risks and will be satisfied with reasonable profits.

What do you consider the most satisfactory experience of your career?

That is a somewhat difficult question, probably my twenty-odd years at the North Star mine have been the most satisfactory. There were several quite interesting engineering problems to work out: a good hard fight at times, when men had to be held to their work with moral suasion and profanity properly blended. There were times of discouragement, of course. I remember Hague saying to me very pleasantly, "Do you know, Arthur, you have spent over a million dollars since giving us a cent". Mr. Hague was a most delightful man to work for. His sense of humor would dominate any occasion and cover all trouble. He never bothered me with details. His only specification for a stamp-mill that was to cost $80,000 was, "Build it to last thirty years". So I built the mill of stone and iron, and it was satisfactory. Hague died in 1908, just at the beginning of our reward for ten long years of preparation. That year the mine produced over a million dollars and continued at that rate until war

prices shut us down. After James D. Hague died, his son William, or 'Billy' as everyone called him, came out as managing director. He built a house and brought his charming wife out, and his children were born here. As I had turned over the active charge of the properties to my son, I had the pleasure of watching the second generation carrying on the work of their fathers until the War came. Yes, I think I may say that the years from 1895 to 1916 were the most satisfactory or the least unsatisfactory of my life.

A YANKEE ENGINEER

*Among the pine-clad slopes of the Sierra Nevada, on the Pacific side and overlooking the central valley of California, is a pretty settlement called Grass Valley. It is a community devoted to gold mining, and is distinguished among other Californian mining centres as the locality where was started the first digging into hard rock for gold-bearing quartz in veins or lodes, following the early washing of the gravel in the river-beds from which the miners of '49 drew their riches. In 1851 the first shaft was sunk on Massachusetts hill; now the Empire mine has a vertical depth of 2705 feet and the North Star is 2500 feet deep; but these figures fail to measure the extent of the mining operations, because the North Star shaft, for example, follows the dip of a flat vein so that it is 6300 feet long from top to bottom, where, by the way, it is just a hundred feet below sea-level. The North Star has had its vicissitudes, like most mines, but it has been yielding gold almost continuously for 25 years. Moreover, it has been a mining school to a number of engineers now playing a useful part in the world. Originally it was an undertaking launched by that fine old gentleman, James D. Hague, and it was opened up under the technical direction of another engineer of the old school, the school of scholars and gentlemen. We publish an interview with the veteran manager, Mr. Arthur DeW. Foote, now partly retired and succeeded by his son. The story of the big men connected with the big mines is more interesting, we venture to suggest, than the statistics of production or than even the evolution of technical processes. Mr. Foote is a repre-

*Editorial in the 'Mining and Scientific Press' of December 25, 1920.

sentative American, in his ancestry, his early environment, his schooling, and the venturesome beginnings of his professional career. The interview shows that he is direct and outspoken, eschewing periphrasis. He speaks of men as he found them—and he had to deal with many kinds—but in all his dealings he asserted the essential manhood and self-respect that we like to consider peculiarly American. He could look any man in the face, and, if necessary, tell him to go to hell; but he did not say it too often, and he never said it without cause. He was always kindly and polite to those with whom he worked, either as subordinate or chief. Mr. William Hood, the veteran railroad engineer, to whom Mr. Foote was assistant 45 years ago, tells us that he was "exceedingly competent in his work and a most agreeable gentleman, with whom it was a pleasure and privilege to be associated". Another veteran engineer, Mr. Edward A. Rix, says that Mr. Foote impressed him always as "singularly fair and just in his dealings". He is a civil mining engineer in a double sense; he began with tunnel and railroad work, and then turned to hydraulic engineering on a large scale, before drifting into mining and metallurgy. His early training made him keen in the selection of the machinery employed in mining and more particularly the use of compressed air, for pumping and hoisting, as well as drilling. In this branch of mechanical engineering he was a pioneer, and, as the interview records, he found keen pleasure in planning and devising (with Mr. Rix, a specialist) new types of compressed-air machines, which were then, 25 years ago, in their infancy of development. He had the courage of his convictions, reinforced by a thorough knowledge of the principles involved. For example, the ordering of the 18-foot direct-connected Pelton water-wheel, which actuated the first compressor at the North Star, required some nerve, for it was of much larger diameter than any previously constructed and was built with spokes in tension like a bicycle-wheel. Mr. Rix says: "The usual knockers lined the fences to see her blow up when started, but they were disappointed". Mr. Foote has decided ideas on education, more particularly the need for teaching English to engineering students. He becomes explosive in talking of the jargon that is the accepted medium of literary communication among members of the profession. He has an understanding sympathy for the toilers underground and recog-

nizes that the entire morale of a working force depends upon the personality of the manager, superintendent, and foreman. He places his finger on *the* weak spot of industrial management, namely, the increase in the size of the operations and the number of men employed to such an extent that personal influence becomes extinguished and the relation of a manager to his employees becomes de-humanized. That is repellant to him, for his traditions and his education alike have given him a feeling of keen responsibility to the men whose work he directs and an appreciation of their troubles and distempers. He is like the type of Colonel who is a father to his regiment. Which reminds us that he appears disguised by literary art in a book called 'The Ground Swell', written by his wife, who, as Mary Hallock Foote, is known to many of our readers as the author of 'The Led Horse Claim', 'The Valley Road', 'The Chosen Valley', and a number of other books in which the refined imagination and the tender feeling of a New England gentlewoman give charm and reality to divers phases of Western life. In the retired General of 'The Ground Swell' we catch glimpses of our mining engineer at Grass Valley. "When he's happy he drops into Uncle Remus talk; when he is very happy he becomes nautical. In his far-off boyhood he had played with boats." Again: "My husband could do foolish things with money, but he had a long-distance wisdom at times that money cannot buy". When things did no go quite right he would describe them humorously, "not being a bitter person". As for example, in his disagreement with Adolf Sutro. It is a great help to one's philosophy of life to be able to see a joke against oneself; indeed it is the supreme test of humor. Looking at Mr. Foote's career as a whole, it may be remarked that a good training in any branch of engineering is a preparation for any other branch of the profession; undoubtedly mining engineering benefits from the incursion of ideas brought to it by competent civil engineers, and there is something in Mr. Foote's remark that the civil engineer or the hydraulic engineer has "a broader education and a broader scope" than the mining engineer; in short, much that the members of our profession are called upon to do is only slightly related to their technical training, but, for that reason, there is more opportunity, we believe, for the play of personal character in mining than in other phases of "the art of directing

the great sources of power in Nature for the use and convenience of man". In the exercise of that art it is necessary not only to direct natural sources of power but to direct the energies of human beings, and therein lie its chief interest, difficulty, and importance. Modern industry has developed an ugly aspect, largely because, with all the improvements in mechanics and in chemistry, we have not produced a sufficient number of men competent in character to be given the charge of large numbers of their fellow-men. That is the main problem facing our industrial democracy. We need more engineers like Mr. Foote, alert and sagacious, but also humane and sympathetic to those who work *with* him rather than *for* him; in short, the democratic ideal of industry is not serfdom but co-operation.

DANIEL C. JACKLING

AN INTERVIEW

Mr. Jackling, you are a Western man?

I was born in Missouri, and have lived in the West all my life.

When and where were you born?

My father and mother lived in Bates county, before there were any railroads west of St. Louis. My father was engaged in the trading and forwarding business, on the Santa Fe trail, at the old town of Hudson, near what is now Appleton City. I was born there in 1869.

Your people were of old American stock?

My mother's people were of old American stock, but my father came from England while a young man; he was naturalized in this country not long afterward; and for a time, immediately following the rush of settlers in the early 'fifties, was engaged in a small way in the shipping business of the Pacific Coast. None of his relatives came to this country so far as I know, except one sister, whom I never saw.

From what part of England did your father come?

His family lived in Lincolnshire, but he went to Liverpool while he was a boy.

That accounts for his interest in shipping?

Probably.

Will you outline your early education?

It so happened that my father died before I was a year old, and my mother before I was two years old; and as I knew nothing of the whereabouts of my father's relatives, if there were any at that time in this country, to all practical purposes I

had no relatives on my father's side, so I was taken to live with a maiden aunt, my mother's sister.

What was her name?

Her name was Abigail Dunn, a good old Irish name. My father's stock was English and Scotch, his father having been an Englishman. My mother's family were originally Irish.

Please proceed to describe your education.

My mother's sister married a farmer. We lived on a farm during all my early life, migrating from one point to another, sometimes settling for a year or so in one place. First we went from Missouri to Arkansas; from Arkansas to Illinois; from Illinois back to Missouri, and rambled all over that country during my boyhood, until the time that I first went to a little schoolhouse near Monmouth, Illinois. I didn't start to go to school until I was old enough to walk the two miles and return alone. As I had opportunities, I went to the common district-schools during the winter, possibly half the winter, until I was about 16 years old; and then my aunt's family, with whom I lived, moved to Sedalia, Missouri. Prior to that time, I had been living on a farm in the Flint Hill country bordering the Missouri river, where picking was pretty thin.

At Sedalia, I managed to go to the public schools for two terms, and just got into the eighth grade. Part of the time I was working for my uncle as a teamster, hauling wood, on public work, hauling earth from excavations, stones for foundations, brick for buildings, and all that sort of thing, nearly always as a teamster. Then I worked out for a year on a farm at $14 a month, and commenced to save a little money. I came back and worked again for my uncle at this same sort of general work, driving a team—that was the only thing I had ever known. After an interval I resumed work on the farm for another summer.

Had you any idea of a career?

I was then 19 years old and had made up my mind that I wanted to go to school; in fact, I got the idea of wanting something more of an education through a nephew of the man for whom I was working on the farm. The nephew was teaching in the district-school, getting $30 a month and board. He went

up to St. Joseph and got a job clerking in a hardware store at $75 a month. I heard his aunt and uncle talking about how well he was doing, and I reckoned that if I could become a school-teacher I might also get to be a clerk and make $75 a month myself. I was only getting $14 a month, but saving some of that; and I figured that if I could earn $75 as a clerk, I could save at least $60 each month. Good farm-land was only $20 an acre, so I calculated I could save enough to buy three acres each month, or 36 acres a year. Eighty or 100 acres of land was a good tract, and I could see my way to agricultural independence; and agriculture was the thing I knew best.

So what did you do?

I went back home, and got things shaped around so I could go to the State Normal school, at Warrensburg, Missouri, at the beginning of the term in September 1888. I stayed there that year, and got along pretty well; but concluded that school-teaching wasn't exactly the thing I was looking for; and began giving considerable thought to the question of engineering.

How did that idea arise in your mind?

While teaming I had become interested in the work of city engineering, such as laying out streets, and that sort of thing; I hadn't seen any real engineering, but the use of the transit and level captivated me; so I got it into my mind that I would like to study civil engineering. I worked again on the farm that summer, and in the autumn of 1889, when I was 20 years old, I started for the Missouri School of Mines, at Rolla, Missouri.

Were you sufficiently prepared to enter?

I was not sufficiently advanced to enter in the freshman year of any technical course, so I had to take some preparatory work, and pursue a mixed course for the first year. I didn't have any money, except what I had earned myself in these years on the farm and otherwise, but I had earned about enough to pay for my first year. It didn't cost me much, because I got room and board for $12.50 a month.

In what other ways did you obtain funds?

During the summer vacations of the first and second years, I

got a job on the M. K. & T. railroad, in the maintenance-of-way department, and worked in Texas, Indian Territory, and Kansas. Thus for part of the time I had to do with real construction work, building an extension of that line from Coffeyville, Kansas, into Indian Territory, now Oklahoma. I had my first real engineering experience there, and by the time I had worked my second summer, I began to get some knowledge of engineering things. I went back to the School of Mines again in the fall; and the next summer, I stayed on during a summer session. In the meantime I had been appointed student-assistant to the Professor of Chemistry and Metallurgy.

What was his name?

Cuthbert P. Conrad. I think he was from Pennsylvania. Early in the following year he died, and I then had charge of the chemical department, and at the same time I was carrying on my own studies.

In which branch of engineering?

I had abandoned the civil engineering course, as my experience on the railroad did not appeal to me. I wanted to take a course in mining engineering and metallurgy, but didn't have time to do it. The metallurgical course was shorter, so I worked to the degree of Bachelor of Science in Metallurgy. According to the rules of the Missouri School of Mines, it requires some practical work before one can get the degree of Metallurgical Engineer.

In what year did you graduate?

Going unprepared in 1889, and in part earning my own way by working during my vacations and being assistant in teaching part of the time, I finished the four years' course in three years, and graduated in 1892. I did not get my engineer's degree until ten years afterward, in 1903.

What did you do then?

I stayed at the Missouri School of Mines as Assistant Professor in Chemistry and Metallurgy for another year after I had graduated, and left there finally in 1893.

And you went from there to——?

I changed my mind pretty frequently. First I was going

to be a school-teacher; then a civil engineer; then a mining engineer, but found my work was leading me into metallurgical studies, and lastly I was pruning again for a career of teaching. After a year of that, I concluded I didn't like it, pulled up without anything particular in view, and started out to look for a job. I went to my uncle's farm during the summer months, and tried to find a position by correspondence. I was offered a position as teacher in some of the schools, but I had decided I didn't want that; so in the autumn of 1893, I went to Kansas City. The old Kansas City Consolidated Co.'s Argentine plant was running then, and some of my friends were working there.

Whom did you meet there?

Curtis Alexander was the assayer, and I tried to get a position from him, but failed. The only thing I could get was a job pushing slag-pots. That was all right, but just about that time Cripple Creek was beginning to attract a good deal of attention. and I decided I would go there.

Did you know anybody at Cripple Creek?

I didn't know anybody in the West at all, but I got together what few things I had and prepared to go anyway. I found I hadn't enough money to pay for a ticket, but I got a little from my aunt; she did not have much, but had always helped me some, so I borrowed enough money from her to get me to Colorado Springs. I landed there a day or two after New Year's day, 1894; and went up on the Midland railroad to Divide the next morning. There was no railroad into Cripple Creek then. I could not afford to take the stage, so I got a fellow-passenger to take my grip on the stage, and I traveled along behind on foot to Cripple Creek, walking the 18 miles.

Whom did you meet first in Cripple Creek?

I didn't meet anybody that I knew there. I had never been west of Kansas City, and didn't know a soul in Colorado. Some of the boys from the Missouri School of Mines came from Colorado, but their whereabouts were vague to me, so I was without an acquaintance in Cripple Creek.

How much of your money was left?

I had only three dollars when I got to Cripple Creek, and

that didn't last very long. One couldn't buy much with three dollars in Cripple Creek at that time. I spent all my money for food and was unable to pay for a room. I went to Victor, but couldn't find anything there either, and finally wound up on top of Bull hill, where I obtained a job bucking samples in J. C. Staats' assay-office, near the old Pharmacist mine. That was early in January 1894.

So that was your first work in mining?

Yes. I worked for Staats for a while, and when he wanted to go away for two or three months, I ran his business. I did well; it paid very nicely. In the meantime, the first Cripple Creek strike came on. By that time I had located some people I knew. One of them was F. N. Flynn, who had been an undergraduate student with me at the School of Mines. Later on, when Staats came back and took his business, I went to work in a shaft on the old Lottie Gibson, but only worked there a short time.

And what was your next step?

In the meantime Ed. Holden, Charlie MacNeill, George Pierce (of the Golden Fleece mine), and Captain De Lamar had organized a company for starting the first barrel-chlorination plant in Colorado, and were about to rehabilitate an old stamp-mill some little distance below Victor, known as the Lawrence plant. I had heard of this scheme and had talked to Staats about it. He telephoned to Charlie MacNeill for me. Charlie was secretary of the company. I went down there to get a job, and bumped into Ed. Holden, who was running the business as the chief executive. Dawson Hawkins was superintendent. I saw them start on practically the first reconstruction of that old plant, which proved to be the one in which the chlorination process that took so much gold out of the Cripple Creek ores was developed. Chlorination was ahead of cyanidation. John E. Rothwell was there part of the time. He had been engaged as consulting engineer, and had come down from the Golden Reward, in the Black Hills, where he had been putting in a barrel-chlorination plant.

What appointment did you obtain?

I started to work at the Lawrence plant as assayer, and, as time went on, got more deeply into the technical department,

and pretty soon I was doing all the chemical work. Finally the chiefs of the metallurgical department, Rothwell, Hawkins, and all the rest of them, went away, and I was the chemist and metallurgist for the plant.

That must have been in 1894, for I remember examining the Elkton and going down to the Lawrence plant with Dawson Hawkins, who introduced us. Do you remember?

Yes, I do. That was in the fall of 1894. I stayed there until the latter part of 1895, when the plant burned down.

But chlorination had won a foothold, had it not?

Out of the Lawrence experience grew the MacNeill and Penrose installations at Colorado City. The Gillette plant, a small chlorination mill, was built in the meantime at Grassy by Ned Hawkins, a brother of Dawson Hawkins. Dawson had left Lawrence, as I have said, and I don't know but what he was associated with his brother Ned for a while in building this Gillette plant.

After the Lawrence plant was destroyed, MacNeill got together another organization, using the data from the Lawrence experience, and organized the Colorado-Philadelphia Reduction Co., which built what was called the Colorado plant. That was the first big chlorination plant in Colorado, and was at Colorado City. Later they built a still larger plant, called the Standard, also at Colorado City. In the meantime, Argall had built his Metallic Extraction cyanide plant at Florence; and then others followed. The whole metallurgical trend for Cripple Creek ores, outside of Argall's work, was toward chlorination. The National mill was built at Florence, and was a good-sized plant; the Union, which was a large plant, was also built there; and about the same time the Portland mill was built. The Lawrence mill was the nucleus from which grew the reduction works that for a great many years treated nearly all of the Cripple Creek output. Argall's plant was closed down when the United States Reduction & Refining Co. was organized, but he lived to see his ideas re-established, although along somewhat different lines.

The burning of the Lawrence plant was the end of my experience in the Cripple Creek district. I then made some examinations for Captain De Lamar, who owned a large interest in this

Lawrence plant, but he did not go into the Colorado City enterprise. In the meantime De Lamar had become interested in the Mercur district, Utah, and had organized a company called De Lamar's Mercur Mines.

But this enterprise did not include a chlorination mill?

No. The old Mercur Gold Mining Co. was the first in the country that had employed the cyanide process successfully, and upon a considerable scale. It had used it on the oxidized ores of the upper zones. The mines controlled by Captain De Lamar lay at a lower geological horizon; and a large part—the most important portion—of their orebodies was non-oxidized ore that was not amenable to any known method of treatment in their natural state, on account of base sulphides of various kinds. There was almost everything that one could imagine, but the principal refractory constituents were mispickel, the arsenide of iron, and the two arsenides of sulphur, realgar and orpiment.

Did you find a way of treating this ore?

Captain De Lamar acquired these interests in 1895, or about that time, and during that year sent considerable quantities of these ores over to me for experiments at the Lawrence plant. I thought there was a way out of the difficulty in treating them; very few others did. He had sent samples to Europe and elsewhere, and the metallurgists had all reported that there was no method applicable to that low-grade refractory ore. I had made some experiments in Colorado, and thought something could be done. At the same time, I had conducted a series of experiments on the ore of the Jim Crow and Monitor mines, which formed the basis of De Lamar's Nevada property, not far from Milford. Early in the year 1896, De Lamar engaged me to go to Mercur and commence more extensive experiments, on my representation to him that I had obtained some results that were promising, and that I believed offered a solution of his problem.

What men were there at that time?

George H. Robinson was manager of the De Lamar Mines then; and R. H. Terhune, of the old Hanauer smelter at Salt Lake City, had been engaged as metallurgist to advise him about some method of treatment; but nothing had been done at all. I took hold of the research and worked with Terhune. After a

little while, he dropped out, and I was authorized to build an experimental plant. In two or three months, in May or June, 1896, we had the little plant ready, and commenced operating on a small scale, a few tons a week, getting good results. I carried the experiments through until late in that year, and got definite and satisfactory results, which I believe were among the first, if not the first, based upon the roasting of ores for cyanide treatment anywhere in the world. Argall may have done it at Florence before; but the work at Mercur was the basis of the first big installation of a cyanide plant that contemplated the roasting of ores before cyanidation.

What were your difficulties?

We had a problem more serious than the elimination of the sulphur; and that was the lime and clay base of the ore which formed naturally a good cement-making product; so that after we roasted the ore and put it into vats to leach, we found it setting into masses of solid concrete. We had that to overcome, and we did overcome it by carefully wetting, mixing, and seasoning the ore before charging it into leaching-vats. At the end of that year, we commenced designing a 500-ton plant.

What other innovations do you recall?

That experimental plant was, so far as I know, the first in the country in which powdered zinc was used as a precipitant for cyanide solutions on a commercial scale. C. W. Merrill came there with Henry Bratnober and others in the autumn of 1896 to examine the mines, and I believe Merrill saw there the use of zinc-dust for precipitation on a commercial scale for the first time. I used it in the old way—adding it direct to the solution-vats and agitating with air. In the meantime, between the operation of this experimental plant and the construction of the first section of the De Lamar Mercur Mines mill, the De Lamar Nevada Mines had changed their process from chlorination to cyanidation, and there used on a large scale zinc-dust precipitation before we used it on a similar scale at Mercur; but the application of it on a working scale was elaborated in the little experimental plant at Mercur.

Early in our use of zinc-dust, we found that certain kinds didn't give as satisfactory results as other kinds, and by analysis

I determined that the amount of impurities had a marked effect, and found that the purer dust didn't work so well as that which was less pure and contained some considerable percentages of lead; so I corrected the defect in the purer dust, so far as I know for the first time, by adding a solution of lead acetate to the precipitation-vats. I believe that sodium cyanide was used in this mill at Mercur for the first time, on a large scale.

In what year was that?

We started to build a 500-ton plant at Mercur in the summer of 1897, commencing on the foundations in June of that year; and in April 1898 we ran the first ore through it, having built the first all-steel mill in the West; and having employed in a large way, for the first time, electric current transmitted at 40,000 volts for milling purposes, using the induction-motor. L. L. Nunn built the Telluride power-plant at Provo, and had introduced these improvements in a small way in Colorado, but we took this power at 40,000 volts and had the first large installation served by high-potential transmission in America, I think—in the Golden Gate mill at Mercur. Anyhow, so far as I know, we used for metallurgical purposes of that kind, and on a considerable scale, the first induction-motors to be so used. We had a good deal of trouble in starting up that plant: we had introduced so many new devices. There was some trouble with the power; and we found that the roasting-furnaces were not particularly well adapted; so we had to design our own furnaces.

What furnaces were you using?

The straight-line roaster, of Horace F. Brown. We had a double problem, one of roasting and one of cooling. The Brown furnace did the roasting, but we had to combine cooling and spraying to get the product in proper condition to put in the vats. One of the methods for overcoming the 'setting' of the cement-like material produced by roasting was to spray the ore with water while it underwent stirring and cooling, and thus allow it to agglomerate and set in small granules, which were sufficiently porous for good leaching. We further overcame the 'setting' by mixing with the roasted ores a certain percentage of oxidized ores that did not need roasting and only required comparatively coarse crushing, so we finally got a product that would leach

satisfactorily and could be removed from the vats without difficulty.

What furnaces did you use then?

We remodeled the Brown furnaces and got them to working fairly well, employing for the first time, so far as I know, the top of the furnace for a cooling-hearth. We sprayed water on that, and got a satisfactory product. We then designed a furnace of our own that was called the Jackling furnace. It was designed not because I had any ambition to invent a new apparatus to bear my name, but to meet a necessity. In the meantime we had put in some Holthoff-Wethey furnaces. We started with four furnaces only of the Brown type, later adding two of the Holthoff-Wethey type, and then three of the so-called Jackling type.

Who was manager of the Golden Gate mine at that time?

In the meantime, George H. Robinson had resigned, and H. A. Cohen became general manager, and he in turn was succeeded by Victor Clement. Duncan MacVichie was superintendent of the underground operations and I was superintendent of the surface operations.

We employed there, I think for the first time, a large-capacity induction-motor electric hoist. This hoist was controlled by friction-clutches and reversing-gears between the motor and the drum.

Won't you say something about the first use of sodium cyanide?

I found we had so many acid salts, which we were pleased to call 'cyanicides' at that time, that the consumption of cyanide was very high. Potassium cyanide pretty nearly all came from across the water, and was expensive. In order to overcome these cyanicides, we bought soda-ash as a neutralizer, and used that in making up stock solutions before adding cyanide. The first observation that suggested the use of sodium cyanide was due to our having received a lot of potassium cyanide that was very impure, and the question was raised as to whether or not that was as valuable as the purer potassium cyanide. I reasoned that if I had a solution of alkaline cyanides with a very large quantity of caustic soda present, I didn't know whether I had potassium or sodium cyanide, and, as a matter of fact, sodium having a lower

equivalent, that if we used more of the sodium cyanide, we would have more of the active agent—cyanogen—present per unit of chemical. Thus it developed that sodium cyanide was just as good for us, and we gradually changed from the use of potassium cyanide, which was expensive, to sodium cyanide, which was much cheaper.

So you began to do good work?

We got that plant into very successful operation, and up to its full tonnage about the end of the year 1898, and began enlarging it; and those enlargements were in part completed, and in part under way, when I resigned in December 1899.

Who succeeded you?

When I left Mercur, I turned the operation of the plant over to F. G. Janney, who became superintendent of the mill. Janney theretofore had been my assistant, practically since the beginning of the construction of the plant in 1897. That was my first association with Janney.

You went to Salt Lake?

No. Clement had resigned; and I went at his suggestion as consulting engineer to design a mill and process for some mines at Republic, Washington. Clement had known something about these mines, and thought they had pretty good prospects.

Was Clement connected with these mines at Republic?

No, but his friends Volney Williamson and Patsy Clark, of Spokane, were. However, before I went there, they had sold out the larger part, if not all, of their interests in the Republic mines to some Canadian people, Clarence McCuaig and other capitalists. I was employed by McCuaig and A. A. Ayer, of Montreal, to go to Republic and design a bigger plant than the one they had there, and a more economical one, which I did. Up to that time, they had been using a small mill, employing the Peletan-Clerici process. I sent my metallurgist, Herbert Fox, to Republic in the latter part of 1899, and he worked out most of the metallurgical data, so that when I went there in 1900, we were pretty well prepared to go ahead. We built a 250-ton mill that year, and started it in the winter, running it the better part of the next year. It did economical work and

made good recoveries, but the ore developments and reserves were not up to expectations, so the mill had to close down late in 1901.

What did you do then?

I went back to Colorado again as consulting engineer for the United States Reduction & Refining Co. under engagement by my old friend MacNeill.

You mean consulting metallurgist?

No, the title was consulting engineer. I was getting out of the technical metallurgy and more into engineering and construction lines.

As I have said, I went back to Colorado, and about that time, the U. S. Reduction & Refining Co. had its attention drawn to the utilization of low-grade lead and zinc ores, more particularly from the Leadville district, as employed in making zinc-lead pigment at Canon City; and they sent me there to look into F. L. Bartlett's plant. The result of that examination was that the U. S. Reduction & Refining Co. purchased the Canon City pigment plant, and sent me to re-build and operate it. I stayed there during 1902 and 1903, and we developed the business to a profitable condition. It would have continued to be profitable for a long time but for the fact that metallurgy was developing more rapidly in other lines.

To what do you refer?

The electro-magnetic separation of zinc and lead ores had commenced to interest people in the West; instead of the Canon City plant being able to get such ores practically on a lead-smelter basis, whereby they paid for the lead while the zinc was penalized, it found itself having to compete with people not only willing to take mixed ores without penalizing them, but beginning to pay something for the zinc, using the Wetherill process. The Empire Zinc Co. in the meantime had built an experimental plant at Canon City and was buying ores; and other plants grew up in Colorado of a similar kind, or at least designed to do the same thing, so that eventually they put the Canon City pigment plant out of business—but not until some time after I had left it.

Where did you go?

[illegible] to [illegible] electric-power [illegible] transmission [illegible] at Jerrur. This [illegible] until the beginning of [illegible].

[illegible] 1898 and 1899, [illegible] De Lamar [illegible] had his attention called [illegible] claims which con[illegible] recent [illegible] Copper [illegible] of [illegible] company organization [illegible] attracted the attention of [illegible] De Lamar's engineers, while working under the management of [illegible] about that time, and following the [illegible] at Jerrur a good deal of attention was being given to [illegible] low-grade gold-ore deposits, mostly in the form of [illegible] in the Bingham district. The old [illegible] mine [illegible] was the nucleus of what was later the Boston Consolidated group, had been first worked for gold. In the meantime Thomas Weir had built a cyanide plant to treat some surface gold ore on the Highland Boy group, which later became known as the [illegible] Consolidated. Others had begun experimental operations at least on similar ores on some of the claims that now form a part of the United States Mining Co.'s holdings, the old Telegraph and Niagara.

The Bail group was first examined by De Lamar's representative with a view to determining whether or not the ore also contained enough gold to make it profitable.

By cyanidation?

Yes. The samples that were taken in 1898 were sent to Mercur for assay, and it was found that there was no considerable quantity of ore containing commercial values in gold; but it was recognized at the same time that a very large quantity of ore did exist containing about 2% copper, and in some places better than that.

Recognized by whom?

It was self evident.

But ore of that low tenor was hardly interesting at that time?

That will develop. I was sent to Bingham about the end of 1898 to take charge of some development work and make a report on the possibility of handling these low-grade copper ores at a profit. I believe the first churn-drilling for the purpose of testing copper orebodies was done at Bingham at that time, when two churn-drill holes were driven to a depth of several hundred feet. We started, in addition to the drilling, to do some tunnelling, and drove several hundred feet at various places into the hill-sides. We remodeled an old five-stamp mill that was on the ground and had been used in the early days as a gold-mill, and crushed several hundred tons of the ore as we took it from the tunnels, concentrating it on Wilfley tables and vanners. We shipped the concentrate to the old Germania smelter near Salt Lake, and I made a report to Captain De Lamar in the summer of 1899 in which I expressed the belief, based upon my investigations, that there was not only a very large quantity of ore that would average 2% copper, but that it could be worked profitably on a large scale.

Who was your assistant?

R. C. Gemmell had for a long time been associated with the Mercur operations as the chief mining engineer, and he assisted me in making that part of the report pertaining to the development of the orebodies and the probable amount of tonnage. We calculated at that time there was definitely demonstrated not less than 9,000,000 tons of ore that would run something better than 2%; and we expressed it as our view that additional development work would result in proving not less than 25,000,000 tons of similar ore.

The report I made to Captain De Lamar contemplated the same general plan of operation that is now employed. I recommended building a plant at what was known as Adamson Springs, not far from the shore of Great Salt Lake, and on precisely the same site that the Magna plant of the Utah Copper Co. now occupies. This recommendation was made because there was neither water supply nor available room for the storage of tailing in the vicinity of Bingham, and the site selected provided ample facilities in both respects. Captain De Lamar, for various reasons, principally, I believe, the large amount of money that

was involved in putting the proposition on a profitable basis, did not look with favor upon it.

What was the price of the mine?

Captain De Lamar had paid $50,000 for a one-fourth interest when he started to develop; he had an option to buy other interests, the terms of which I do not recall now. He had agreed to spend an additional amount in development. The total expenditures in purchase and development made by Captain De Lamar amounted to something less than $100,000. He dropped the proposition, but had acquired a one-fourth interest in the property.

How much money did you estimate would be required to put the enterprise on a profitable footing?

Several million dollars to build a railroad and put the thing on a profitable basis. I recommended an initial operation of 2500 tons per day; that seemed a tremendous figure at that time. Of course, I had in mind an increase of tonnage later, but 2500 tons per day was to be the scope of our operations at the start.

You don't remember the amount of money you estimated to be necessary?

It wasn't very definite, but, roughly speaking, it would have required around $3,000,000.

The matter was dropped, and I then went to Republic, Washington; but I kept the idea in mind, and called the possibilities of the proposition to the attention of several men who were interested in the copper industry. During the next three years, I lost no opportunity of interesting people who had the money and were familiar with the industry in a proposition that I thought offered the biggest opportunity I had ever seen.

You did not succeed at first?

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was not right to dispose of the property to good advantage. He expressed the belief that it would ultimately be valuable, but thought the value was a prospective, rather than a present, one. H. A. Cohen, De Lamar's former manager, was present in Salt Lake City in connection with the power litigation; and I again discussed the matter with him, and told him that if he could secure an option, I believed I could interest my associates in Colorado to an extent that would induce them to provide the money necessary to demonstrate the proposition, at least on a moderate scale. Cohen went to Colonel Wall and succeeded in getting an option on 80% of his 75% interest, or 55% of the property. I took the option to Colorado, and presented it to MacNeill, who, after some hesitation, interested himself to the extent of sending an engineer, selected by R. A. F. Penrose, to go over the property, and sample it, as Gemmell had done in 1898 and 1899.

Who was the engineer?

F. H. Minard. This sampling verified all of my representations and Gemmell's as recorded in our joint report, both as to grade of ore and prospective tonnage; but Mr. Minard expressed the view that more preliminary metallurgical experimentation should be conducted before the proposition would warrant the expenditure of sufficient money to develop and equip it to the extent of a commercial operation. All of the samples, amounting to several tons, were shipped in duplicate to Canon City and to Colorado Springs; and, after verifying the assays, the rejections were gathered together and sent to the Colorado plant, at Colorado City, where they were ground in sampling machinery for a small concentrating test, which verified in every way the results I had obtained in the operation of the little mill in Bingham Canyon in 1898 and 1899.

So your friends were willing to go ahead?

Yes. Mr. MacNeill and his associates decided that the proposition warranted the necessary expenditure to determine whether or not the operation could be made profitable in a comparatively small way, and correspondingly more profitable in a larger way; so a small exploration company was organized to build a mill in Bingham Canyon. We styled it an experimental

plant. This mill was designed for a capacity of 300 tons per day. Construction began in August 1903, and we ran the first ore through the plant in April 1904. The first step toward opening the mine for actual production was taken in November 1903, in starting what was known as the old 'main tunnel'. The plant started up, as stated, in April 1904, but did not develop its full capacity of 300 tons per day for nearly a year.

You might say something about the recoveries, if you can.

From the start, the recoveries verified the preliminary results that had been obtained a few years before, and the plant actually made a profit every month from the day it started.

You don't remember any of the percentages?

We were running on an ore averaging about 2%, and were recovering a little less than 70% of the total copper in a concentrate averaging around 25%. The plant having demonstrated that the mine could be profitably operated, we began making plans for a larger installation at Garfield.

In the meantime, Captain De Lamar's one-fourth interest had been purchased, thereby giving the Utah Copper Co. (of Colorado) an 80% interest in the property; and a new company was formed which took over the original Utah Copper Co.'s 80% and Colonel Wall's 20%, in consideration of stock interests in the new company, which was then called the Utah Copper Co. —the same name, only the original corporation was registered in Colorado, and the present company in New Jersey.

The Copperton plant, as the Bingham Canyon plant was called, was gradually increased until it eventually reached a capacity of 1000 tons per day before it was finally closed-down, after the Magna plant at Garfield had been in operation for some time. The designs for the Garfield plant, which was to have a capacity of 3000 tons per day, were completed in 1905, and we commenced work on the foundations in the autumn of that year. Legal and other complications, however, made it necessary to discontinue construction work for some time. Wall had brought an injunction suit. The money for the construction of the Garfield plant was provided through the sale of $3,000,000 of convertible bonds, most of these being taken by the Messrs. Guggenheim.

Was that the firm of M. Guggenheim's Sons?

No, the Guggenheim Exploration Co. Early in 1906, work was again actively started. In the meantime, it had been decided to build the Magna plant for a capacity of 6000 tons per day, instead of 3000 tons, that is, a plant of twelve sections instead of six sections; and it is interesting to remember that the 12-section plant then started provided the same identical buildings that are now accommodating, and in which for long periods last year we averaged better than 20,000 tons per day. At that time I reckoned that a 'section', as we designated it, of the mill would have a capacity of 500 tons per day. With the same grinding machinery that we then installed, we now grind regularly more than 1500 tons per day in each of the 12 sections.

Was this due to 'speeding up' the machinery?

Yes, and better methods of operation—more method than speed, in improving the operation of rolls and Chilean mills. We are not grinding as fine now as we did then.

You are not grinding as fine now?

No, we cannot grind as fine on the large tonnage we are now handling, but we are preparing to grind finer by aid of heavier and additional machinery, taking advantage of the tremendous improvements in methods of milling that we and others have developed.

The first section of the Magna plant started in the spring of 1907.

That was the year of the panic?

The bad times came in November, when we were just beginning to get well started; but nevertheless we were able to increase our tonnage continuously. I can't say when we got up to the originally contemplated 6000 tons, but we didn't do it for over a year.

Getting back to the mine: at the same time we started to build the Garfield plant, we began to figure out the ultimate plan of mining, which contemplated the use of steam-shovels; and the first steam-shovel was put on the property in 1906, after Mr. Gemmell, who was then general superintendent, had gone with me over the most important steam-shovel operations in the United States, more particularly in the iron regions. W. C. Agnew, the general manager of the Mahoning iron mine, came out and made

a report. He advised us not to attempt steam-shoveling exclusively, as the country was too rough and we never could get elbow-room; he recommended underground mining or 'glory-holing'. I believe he was then recognized as one of the best steam-shovel experts in this country. He said it was not a good steam-shovel proposition, but nevertheless gave us some most valuable advice. We were working all the time in the face of adverse opinions from nearly everybody; nobody thought much of the schemes that we knew we had to employ to make the operation a success.

The development of the mines and their metallurgy from this time forward are well-known history. In 1910, the Utah Copper Company acquired the property of its neighbor, the Boston Consolidated Co., which in the meantime had also constructed a 3000-ton plant at Garfield.

Which is that, the Arthur plant?

Yes, the Arthur plant, which now, under the same roof, has a maximum capacity of more than 15,000 tons per day. The Magna and Arthur plants combined, during the last quarter of last year, treated at times as high as 40,000 tons per day, and averaged during several months last year more than a million tons per month. You know as much about the rest of the history of the Utah Copper Co. as I do.

I know that it led you to go farther afield.

Yes, while we were developing the Utah Copper, we began to investigate other deposits of a similar kind. The first of these was what is now known as the Nevada Consolidated, of which property the Utah Copper Co. acquired control in 1910, simultaneously with its purchase of the Boston Consolidated property. A large part of the data upon which the Nevada Consolidated enterprise was founded was derived from results of operations in Utah; and when the Messrs. Guggenheim acquired control of the Nevada property, before it was thoroughly developed and before construction began on the plants at McGill, I was consulted regarding the location of the plants and the design of them.

The next property to attract the attention of my friends and myself was the group of mines at Ray, Arizona, now known as

the Ray Consolidated. Options were taken on that in 1906, and some exploration by shaft was started. The panic of 1907 delayed developments, which, however, were taken up again late in that year; and the property was finally developed and equipped under my direction.

The Ray was worked unsuccessfully by Alexander Hill, was it not?

Alexander Hill reported on it, but, I believe, it wasn't worked under his direction. Ray had been worked in the 'eighties in a very small way, on some stringers, under much the same conception as some of the property of the Utah Copper had attracted attention in the early days, which resulted in the driving of several tunnels on rich streaks. Later, in 1896 or 1897, an English company built a mill at Kelvin and started to operate; but there was no railroad at hand, and they had based their operations on 4 or 5% ore, which they didn't have in anything but limited quantities.

And then they did not know how to treat the chalcocite?

If they had had 5% ore they would have gotten along all right, but the 2%, of which they had considerable quantities, didn't make both ends meet, and that resulted in failure, so the property lay idle. That was in the late '90s. Between that time and 1906, the Arizona Eastern railway had been built into Kelvin, and a few miles beyond. While Ray was under development, the old Santa Rita mines were brought to the attention of Messrs. Hayden, Stone & Co. by Thomas W. Lawson, A. C. Burrage, and H. H. Rogers, just before Mr. Rogers died. These properties were acquired, and the Chino Copper Co. was formed, that likewise being developed and equipped under my personal direction.

In 1912, the Butte & Superior property also attracted the attention of Messrs. Hayden, Stone & Co. I visited the mines in July 1912 and found that while only relatively small orebodies had been developed, the promise of a much larger one was great. I outlined a plan of development to be pursued for the remainder of that year, and this having fulfilled my expectations, I advised Messrs. Hayden, Stone & Co., in January 1913, to finance the properties for larger operations.

And you, yourself, became interested in them?

Yes, I was interested in all these enterprises, and have always retained as large interests in them as my means would permit.

And you acted as consulting engineer?

I was vice-president and general manager of all of the companies until I relinquished the general manager's title to the local managers, and took to myself that of managing director.

When you went to Butte at that time, you probably had your first glimpse of flotation?

Yes, it was the first I knew about it in practical operation; and the flotation process in its commercial application in a large way in this country was developed by the Butte & Superior Co., under the direction of my engineers.

Which engineers?

Frank Janney, and Frank Janney, Jr., and other engineers that came out of my organization, principally from the Utah Copper Company.

So the Utah Copper in the end was an important factor in flotation?

The general staff operating all these properties was the developing medium for the flotation process.

Will you speak of your Alaskan venture?

In 1911, A. F. Holden and his associates brought to the attention of Hayden, Stone & Co. the Alaska Gastineau mines at Juneau. In 1912, in company with Holden, I visited these properties, and stated my belief that the large deposits of low-grade gold ore there justified development and equipment, which was done; the metallurgical problems and plant-design being worked out by the same engineering staff that had to do with the equipment and metallurgy of all the 'porphyry' properties and the Butte & Superior; and the mine development and equipment being worked out by the men whom we found in charge of the Alaska Gastineau mines when we became interested.

Who would those be?

B. L. Thane and Whipple, his assistant. Thane was the man who was responsible for the mining operations.

You have had some trouble owing to admixture of waste rock?

As a matter of fact, the actual trouble we have experienced was that in parts of the mine, which according to all development records should have yielded a certain grade of ore, it was found when we came to mine it, that the grade wasn't there, and isn't now.

To what extent, Mr. Jackling, do you believe that large bodies of such low-grade ore can be sampled?

Large bodies of the kind of ore that we have in the 'porphyry' deposits, and located as these deposits are, can be thoroughly sampled at reasonable expense, because we can drill them; but large bodies of very low-grade ore, and particularly gold ore, such as those of the Juneau properties, cannot be satisfactorily sampled. We have learned that they cannot be tested within the limits of reasonable expense for development, and with any satisfactory degree of accuracy compared with ordinary deposits.

You agree, then, that we cannot find out how many raisins there are in the cake, except by eating a large portion of the cake?

That is the answer as to a deposit like that exploited by the Alaska Gold Mines. You must mine a large tonnage and mill it and get your result in order to know what the grade of your ore is. The proportion of gold is so small that a few cents per ton—what would be a negligible amount in ordinary ore—makes a vital difference in such low-grade ore; and our experience in Alaska indicates that sampling from development almost invariably shows results higher than they should be. The difference isn't much, only 30 or 40 cents per ton, but that much where the profits were expected to be only 50 or 75 cents per ton is a serious matter.

It is a fact that we know now a thing we didn't know; we had no means of knowing, and no reason to expect before operating the mines, that the grade of ore is quite a few cents a ton less than we thought it was—enough less to make a very important difference. We had a record of milling several hundred thousand tons of ore from a large section of those mines, and this showed the

grade of that section to compare closely with our development grades around it; but it didn't work out that way, and it is apparent now that the section from which the early mining was done, notwithstanding it was not selected—it couldn't have been selected—was a better-grade area than other areas in the development of which the grade appeared to be just as good.

You applied the copper methods of concentration?

Yes, we abandoned in Alaska, as we did in the Boston Consolidated mill, the appliances we thought were obsolete, namely, stamps. We employed rolls and tube-mills in Alaska for fine-grinding and concentration, rather than amalgamation. Our costs are less and our recoveries better than we estimated. There was no error in anything we could demonstrate; we did it on a large scale and the results have proved that we were right. We didn't know so well what was underground; but the best data we could get appeared entirely satisfactory until we began to mine a large tonnage.

Owing to the enormous tonnage of low-grade copper ore at the mines under your control, you are, of course, vitally interested in the flotation litigation?

Naturally so, because flotation has proved the most effective means that we have been able to find to make greater recoveries within the limits of reasonable cost from the finest class of material, which has always been the most troublesome material in concentrating mills. I don't think flotation is a panacea for all ores; and in the development of a new 'porphyry', or any other kind of mine having ores which contain sulphides, I wouldn't abandon the old metallurgical methods by any manner of means. I would continue the use of what I have been pleased to call step-grinding and fractional concentration, getting out as much of the mineral in coarse sizes as possible before grinding finer, getting it cheaper than by flotation, because those are simple operations, mostly mechanical, and can be readily observed, making products better adapted to smelting and easier to handle; then use the flotation process as an adjunct or auxiliary to do better with the very fine products than we can do by any other means at permissible costs.

Do you care to say anything about your policy in regard to the litigation?

No, under the circumstances, I deem it best not to say anything.

What do you consider the most satisfactory episode in your career?

Of course, from both a professional and business standpoint, I have, and always will have, the greatest satisfaction as being the first, so far as I know, to recognize the possibilities of a character of low-grade ore in the Utah Copper Company's properties that had not before been commercialized, and which kind of ore today serves as the basis of more copper production than the total output of the United States at the time I began the development and equipment of the Utah. The United States was refining 900,000,000 pounds of copper per annum when the Utah Copper Company started, and the porphyry coppers, including those of South America, are producing more than that today. I naturally feel the greatest satisfaction in that; but it is only a greater satisfaction in point of precedence and degree; precedence because Utah was the first, and degree because it is the greatest. I have had just as keen a sense of satisfaction in successfully developing the other mines; the success of any one of them has been no more gratifying than that of any other, and my interest in each has been as great as it has been in any other.

A thing that has been about as gratifying to me as anything I have done is having been instrumental in getting together the Utah Power & Light Co. Water-power had not been developed when we started the Utah Copper operations—not to an extent justifying my using it. It wasn't sufficiently dependable, so we built steam-power plants. Later, I thought it should be developed, and called the attention of some of my friends and people in that business to the possibilities of power-development in Utah and Idaho. We purchased the Telluride company's properties, and along with that acquired some 30 other corporations engaged either in the production or distribution of power, and out of all we have built up the present Utah Power & Light Co., of which I am president. This company now supplies the Utah Copper Company with all its power and is one of the greatest institutions of its kind in the country.

Do you think it likely that any further large disseminated copper deposits will be found in the West?

I think in all probability there will be some, but I think the most important ones have been discovered and developed; the reason I think that is because all of those that have come into prominence and are big producers today have been known for generations; engineers and laymen have known they contained copper; there hasn't been a single one actually discovered in recent years. The Utah deposit has been known for fifty years; the soldiers of Johnson's army knew about it and prospected in it. The old Ruth mine, of Nevada, and some of the other deposits there, were worked a very long time ago. Ray has been known for over forty years, since 1874, when I believe the first records show somebody going in there and prospecting streaks of high-grade ore. Chino was worked practically by the ancients; there are records of Mexicans having taken copper out and packed it on the backs of 'jacks' to Mexico City in 1804. In the Miami district, the old Black Warrior and other claims were worked for their oxidized copper ore for a very long time; and the green outcrops of the district were among the earliest known of copper showings in Arizona. The Braden mine was worked by the ancients. The Chuquicamata mine has a record of operations covering hundreds of years. All of the big things of this kind have been well known for their superficial showings of copper ore. People didn't recognize the importance of 'secondary' enrichment; that ore having a low value on the surface was a probable index of higher-grade ores lower down; they looked for veins. Furthermore, modern appliances and metallurgy, as well as cheap transportation and ready markets for large production, were necessary to the success of this kind of enterprise.

What is the outlook for copper after the War?

I think there will come a time after the War—I don't predict how soon—when copper will again be very abundant for the world's needs, and that the price will again reach levels that we speak of as being below normal, having in mind the average price of copper for a decade before the War. I think, however, that the situation will quickly right itself; the price of copper must necessarily tend upward. The average price of the metal for the ten-year period preceding the time when we started opening the Utah mines was about 13½ cents; the average price for a period of ten years following that time was about 15½

cents. We have been running those mines now about 13 years; that would exclude the high prices of 1915 and 1916. I believe that another ten years will show an average price nearer 20 cents than 15, beginning with 1915. The price must necessarily go up, because if we consider all the reported developments of copper ore in the world that can be measured, all of the great 'porphyry' reserves, and only consume copper at the present rate, that is, the present normal rate—the rate prevailing immediately before the War—we haven't enough copper ore in sight in the world to maintain that production and supply that consumption for more than a short generation.

A CAPTAIN OF INDUSTRY

*Some of the great mines of the world are so closely identified with the men that made them that the mine becomes a monument to the fame of the man. Thus Dolcoath unfailingly recalls Capt. Josiah Thomas, the St. John del Rey is associated with George Chalmers, and the Copper Queen with the honored name of James Douglas. Another great copper mine, the greatest copper mine developed to date, is the Utah, which similarly is linked to the name and reputation of Daniel C. Jackling. In this issue we publish an interview with that engineer, whose wealth and success have subjected him to the penalty of being labeled, in the daily press, as a 'copper king' and a 'metal magnate'. To the readers of this paper he is more than that; he is an exponent of American initiative and resourcefulness of the most effective type; he represents the man that can do big things in a big way. Looming large in the public interest he is one concerning whom our readers will like to know; they will ask by what means and by what technical advantages he became prepared for his remarkable career, and to what extent good fortune is responsible for his extraordinary success. Therefore we have interviewed him, asking the questions that would be likely to disclose what manner of man he is. The interview tells that unmistakably. In the first place, he emerged from an uninteresting environment, although his forbears were worthy people and of good stock; but a farm in Missouri is not an incubator congenial to engineering

*Editorial in the 'Mining and Scientific Press' of May 5, 1917.

talent of a high order. An orphan while yet an infant, he lost something that no kind relative could replace. His schooling appears to have been of a desultory kind, and his boyhood wanting in opportunities that would be likely to prepare him to play a leading part in big affairs; however, he showed early intelligence in noting the usefulness of education and in figuring how to make enough money to be independent. That is a good democratic idea: the wish not to be dependent, to make enough money not to have to truckle to anybody, to be able to look any man in the face, and, if necessary, to tell him—what you think. His real instruction began late; he was 19 when he started to go to school regularly and 20 when he entered the School of Mines at Rolla. He tells us how the idea of engineering came to him while watching a surveyor at work; the precision of it captivated him. So he went to Rolla, and there placed his foot on the first rung of a ladder that led to individual effectiveness. At that time he was poor, dependent on the little money earned during vacations, supplemented by such financial assistance as a kindly aunt was able to afford. He worked his way through college. That is a statement true of several distinguished engineers; for example, H. C. Hoover and F. W. Bradley. It is a fine thing to say of any man. Mr. Jackling worked on a railroad during his vacations and then won an appointment as instructor in the Missouri School of Mines, so that he was able to obtain his degree, which he did in a year less than the usual length of time. Already there was evidence of mental power; also of a restless spirit, for he changed his mind several times as to the choice of a career before he selected metallurgy. Just then Cripple Creek was on the boom; he read about it and decided to go thither. His funds were so scanty that he had to walk the last 18 miles of his journey, arriving at Cripple Creek with $3 in his pocket. There must be great satisfaction in this retrospect to a man that now could buy a railroad. Indeed, the taste of poverty and the stimulus imparted by eager necessity are powerful factors in shaping strong character. An assay-office gave him his first start and a man named Staats, whom we also remember, as we do our meeting at that time with the young assayer who was destined to become the great exponent of big-scale copper mining. Then came a bit of good luck. Mr. Jackling's career was affected profoundly by the acquaintance he

formed, at Cripple Creek, with Messrs. Charles M. MacNeill and Albert F. Holden. While serving his metallurgical apprenticeship at the old Lawrence mill, he made friends of these resourceful men. At that time Capt. Joseph R. De Lamar, one of the most picturesque characters in American mining, had noted the keen intelligence of the young metallurgist and asked him to make experiments on the complex ore then being mined at Mercur. That gave young Jackling the chance to investigate various processes, and prepared him for his later work at Mercur, where he won his spurs as a metallurgist. There also he got on the track of bigger game. Capt. De Lamar and Mr. MacNeill were two links in the causation that led to the Utah Copper. In 1898 the group of claims in Bingham Canyon then controlled by Col. E. A. Wall were offered to Capt. De Lamar as affording an opportunity for exploiting a large body of low-grade gold ore by cyanidation. The samples sent to Mercur showed that the gold content was less important than the copper, but the percentage of the latter was too low to be attractive at that time. However, Mr. Jackling, who had charge of the drilling of the ground, and made the necessary metallurgical tests, reported to De Lamar in 1899 that there existed an immense body of low-grade copper ore that could be exploited profitably if the operations were conducted on an adequately large scale. The spending of $3,000,000 preparatory to treating 2500 tons of 2% copper ore per day seemed, at that time, anything but attractive, even to such an enterprising man as De Lamar. So the project was dropped by him, but not by Mr. Jackling, whose ideas of opening up a big thing at Bingham were strengthened by the favorable opinion of Mr. R. C. Gemmell, who assisted him in his first examination of the property and is now the general manager of the great enterprise that resulted therefrom. But the result was not achieved either quickly or easily. Mr. Jackling went back to Colorado, being employed as consulting engineer by his old friend Mr. MacNeill, who had become associated with Messrs. Spencer Penrose and Charles L. Tutt in organizing several important metallurgical plants. By this time Mr. MacNeill had become a capitalist and had won a following among moneyed people in Boston and New York. To him Mr. Jackling brought his vision of a big copper enterprise at Bingham, supplementing his idea with facts and figures of a kind that were

convincing to his friend, who knew him to be no crazy optimist but an engineer with a disciplined imagination. Through Mr. Hartwig Cohen, De Lamar's manager, Mr. Jackling was enabled at last, in 1903, to obtain an option on the property from Colonel Wall. Mr. MacNeill took the business in hand; an independent examination of the prospective mine was made by Mr. F. H. Minard; the ground was sampled on a large scale, and the assays confirmed the figures obtained by Mr. Jackling himself in 1898. Thereupon enough money was raised to build an experimental plant at Bingham. On a 2% ore a 70% recovery in a 25% concentrate was obtained. The experimental mill and the preliminary operations more than paid their way, so that the mill was enlarged gradually to a daily capacity of 1000 tons. Mr. Jackling's judgment was verified, the project was placed well on its feet, the necessary capital was obtained for a steady expansion of operations, but just after the new concentrating plant, of 6000 tons capacity, was started, the enterprise received a dangerous shock from the financial panic that paralyzed American industry near the end of 1907. Mr. Jackling does not say much about that in the interview, but it was a bad moment for the Utah Copper Company. A number of his associates were 'long' on large blocks of the stock and he himself was not in an invulnerable position; but he aided them and was able to protect himself, leaving a pleasant memory of forceful ability in a time of crisis and of personal loyalty to friends. That experience, and others, have established a feeling of comradeship that has proved a powerful aid in his administration of the several big enterprises of which he is the managing director. He has created an organization that is cemented by loyalty. Bluff, blunt, and big-hearted, he loves work for its own sake, he likes to be doing something interesting, he is willing to take chances, and is ambitious to wield power. Congenitally a speculator as well as an engineer, he enjoys an enviable reputation for truthfulness and for straight dealing in business transactions. To his administration of big affairs he applies a mind that is adaptable to new problems and shows ability to remember intricate details easily; and he knows when he makes a mistake—that is a saving grace lacking in many successful men. His frank acknowledgment of the miscalculation at Juneau is peculiarly instructive and disarming. He was

drawn into that affair through the late Albert Holden, a daring speculator and a man of remarkable initiative. Mr. Jackling thought he could apply the big-scale copper methods to a large low-grade gold deposit, and he succeeded up to the point where one factor went wrong, namely, the estimation of the average tenor of the ore. The big sample—375,000 tons—broken in the Perseverence mine by the old company, and the milling of other large tonnages, from later development work, failed to give a true average. The yield proved less than anticipated, so that, although the estimate of cost was fully confirmed, the net result was disappointing. Mr. Jackling discusses the matter frankly and clearly. Many will find this the most interesting part of the interview. It shows that he is not so spoiled by fortune as to be unable to learn. Only 47, he will accomplish more yet. A farm-laborer at 18 and a millionaire at 40, he maintains a keen interest in the metallurgical operations by which he found a way to distinction in the profession. Today he directs the exploitation of a group of mines that will produce 600,000,000 tons of copper ore in the next 30 years. That makes the Rio Tinto and the Calumet & Hecla look small. There is much left for him to do, and in the doing of it we wish him some of the luck that every miner needs. His career testifies to the opportunities that the United States offers to the hard-working, self-reliant, keenly observant young man. His is one of those romances of industry on which we may dwell with pleasure. To other young men of this democracy it is an encouragement to work hard and to work intelligently not only, or chiefly, to make money, but to win the supreme delight of a great achievement.

HENNEN JENNINGS

AN INTERVIEW

Mr. Jennings, you were born in the West?

No, I spent some ten years in California after leaving college, but I was born in 1854 at Hawesville, Kentucky, a small mining town on the Ohio river. At that time my father was the owner of a bituminous coal mine. He had come from New Orleans, where he was connected with large shipping interests.

Was the enterprise successful?

It was very tempting in that the coal outcropped along the river-bank and could be loaded by gravity-incline direct on barges in the river, but my father had no experience or training in coal mining, and the coal was found to be unsuitable for shipping south, as he had hoped. The river-steamboat market was limited, and although the mine was worked for a long time the venture proved unsuccessful.

What was your early education?

The Civil War interfered with my regular attendance at school, but my mother, a woman of rare culture, was my teacher and inspiration. Just after the war, when 13 years of age, I went with relatives to England, remaining there three or four years, part of the time at school in London and over two years at a small school in Derbyshire, at Farnah Hall, where I enjoyed a wholesome health-giving country life, and was stimulated in engineering matters by my teacher, Rev. E. E. Montford, who had love and attainment in mechanical and scientific subjects. Soon after my return to Kentucky my father died and I started to work.

What sort of work was it?

I erected a saw-mill on some timber property that had been owned by my father. I made a little money out of the lumber

business and in such a way that it attracted the favorable attention of a relative who aided me in going to college.

You went to Harvard?

Yes, I graduated from the Lawrence Scientific School of the Science Department of Harvard in 1877.

That had not been long started?

The Lawrence Scientific School at Harvard is probably the oldest scientific school in the United States. It was started in 1847.

I suppose Shaler was the most interesting of your teachers?

Professor N. S. Shaler was under forty when I first met him, but his rare personality was felt by all the students who came in close touch with him. His course in geology was largely attended by the academic students as well as the scientific. His subsequent writings have shown him to rank high as a philosopher and poet, as well as a scientist. But above all, he showed himself a big-hearted human being to whom the students could turn for advice and comfort in time of trouble. One of his desires and aims was to bring the academic and scientific students in closer touch and to obtain for the future engineer a broader and more liberal education. The school was at a low ebb in point of members when I was connected with it, but some years later Shaler was appointed Dean and under his administration the scope of the work was enlarged, the social life of the students in the academic and scientific departments became more unified, and the attendance increased from 30 to over 500 students.

You were fortunate in coming under Shaler's influence?

Most decidedly. Shaler was the personality among my instructors that impressed me most. I had come to college unknown by him, but soon after my arrival he came to my room, having seen my name registered from Kentucky. He was a Kentuckian. He thought I might be lonely and came to give me a friendly welcome. He invited me to his house and I had the privilege of considering him a true friend as well as teacher until his death.

You took the course in Mining Engineering?

No. The mining course was not then well established. I took the course in Civil Engineering, which gave all the preliminary training required for mining engineering. I obtained the degree of Civil Engineer in 1877.

How did your education at Harvard fit you for your subsequent career?

The course then given has been greatly improved, but as it was it educated me in mental concentration and effort, and afforded me the foundation of general principles in engineering.

You found plenty of mental stimulus?

Yes. I was thrown not only into contact with my own classmates, but I made friends of students in other departments of the University and also with some of the distinguished men among the teachers. At that time there were concentrated at Cambridge and its vicinity a number of men of great distinction. Charles William Eliot was then a young and active president; Oliver Wendell Holmes and James Russell Lowell were lecturers; Henry Adams, John Fiske, and William James were connected with the University in the Academic Department in their several specialties. In the Scientific Department, Benjamin and James M. Pierce and Henry Lawrence Eustis were professors of mathematics; Asa Gray was professor of Natural History; Walcott Gibbs and John Trowbridge were Professor and Instructor, respectively, of Physics; Josiah Cook, Professor of Chemistry; and Josiah D. Whitney, Professor of Economic Geology. Longfellow was then living at Cambridge, and Emerson at Concord. Naturally I absorbed some of the atmosphere created by these men.

When you left Harvard did you get a job at once?

Yes, I did, by the aid of my friend Hamilton Smith, who came from a little town in Indiana opposite my home on the Ohio river.

What was the nature of your first work?

Chiefly clerical, in connection with the reconstruction and enlargement of a crib-dam by the North Bloomfield Co. in Nevada county, California. In the issuance of supplies and keeping of

[illegible] obtained [illegible] North Bloom-[illegible] difference [illegible] accounts and [illegible]

[illegible]

[illegible] the [illegible] work, and [illegible] advantage for [illegible] attention of [illegible] master in [illegible] confidence. [illegible] this country [illegible]

[illegible]

[illegible] friend and [illegible] the [illegible] was [illegible] by his [illegible] Our first [illegible]

[illegible]

[illegible] and at North Bloom-[illegible] of introduction from [illegible] of the New Almaden quicksilver [illegible] receiving a salary of \$40 per [illegible] At Almaden I had the good [illegible] of a man who is one of the most [illegible] been my privilege to know— [illegible] with him the quicksilver mines. [illegible] Mr. Browne left New Almaden to [illegible] at the University of California, and I was then

made chief surveyor. By reason of the training he had given me, I was able to come into engineering prominence through the close-connecting surveys that I made in the mine under difficult conditions. This gave me my first step in the profession.

How long were you at New Almaden?

I was there in all about seven years, but with a break of two or three years. After making the survey I received an appointment as assistant to Mr. Perkins at North Bloomfield again, and I stayed with him about 18 months; after which he gave me charge of my first mine—the Ruby Gold gravel mine in Sierra county, the continuation of the Bald Mountain channel on the Forest Hill divide. At this mine we were disappointed in trying to intersect the channel, but afterward a deeper channel was cut by our tunnel, and in the finding of this, some reasonable hopefulness on my part gave me my first winning, because some of the owners abandoned the undertaking, permitting me to take some of their stock, which later proved profitable.

The mine was shut-down?

No, it was worked for several years after my departure and paid dividends under the foreman. I, however, was offered by Mr. Randol the position as superintendent of the New Almaden mine, and accepted. Randol had the reputation of being a hard taskmaster, but he proved an excellent friend to me and kept me up to the mark. The position afforded me an opportunity of working a complex lode and experience in working men on contract as well as day's pay.

Whom did you get to know at New Almaden?

While at New Almaden I first met Professor Christy, for whom I ever after retained a high regard. I came in touch with Fred Bradley, then a student from Berkeley; also with Edward Benjamin, at that time model-making; and with Charles Butters, who acted as chemist for a short time while I was surveyor and engineer. George F. Becker made a geological examination of the district while I was there and I had the good fortune of again meeting him in South Africa, and the privilege of having him now as one of my Washington friends. I remained at New

Almaden until 1887, when I went to Venezuela to take charge, as manager, of the El Callao mine.

Were you not married in California?

Yes. I was married in 1886 to Miss Mary L. Coleman, daughter of John C. Coleman, one of the venturesome pioneers of 1850 who, with his brother, was successful in mining ventures. They were at one time chief owners of the Idaho mine at Grass Valley. Prior to this they were engaged in hydraulic mining at Iowa Hill. The soil on which was erected the house where my wife was born was later hydraulicked away, so there is a doubt whether the place of her birth is Placer county or the Bay of San Francisco!

Were you asked by Mr. Perkins to join him at El Callao?

Yes. He, and Hamilton Smith, who was acting consulting engineer of the El Callao Mining Co., arranged for me to succeed Perkins as manager. The mine had just passed its maximum activity; two years previous it was the greatest gold mine in the world, yielding $200,000 per month.

Can you give some further facts concerning this celebrated mine?

The mine is situated on the Yuruari river, about 150 miles south-west of Ciudad Boliva, in Lat. 6° N. It is on the fringe of forest-land near the Savannas. It was owned by a Venezuelan company, but stock was largely held in England, although the control was in Venezuela. It was opened up by a company of Corsican traders, of whom one Liccioni was first president and chief owner. The existence of gold was known to the natives as far back as 1849 and attracted the attention of the Corsican owners soon after. At first it was supposed to be a gravel deposit, but in working to bedrock the vein was uncovered; there was a phenomenal amount of visible gold in white quartz, and for a length of two to three hundred feet a shoot of rich specimen ore was found. The lode was finally exploited near the surface over a length of about 1000 ft. down to 900 ft. vertical. About $30,000,000 was taken from the deposit. Work was started with small crushings in ordinary mortars and then a 10-stamp mill was erected, which was enlarged to 60 stamps before Mr. Perkins' arrival. The early crushings gave over $100 per ton,

but costs were from $30 to $40 per ton. Under the able management of Perkins, and with ample funds at command, a new 60-stamp mill was constructed and the whole work thoroughly reorganized. The working cost was reduced to $13 per ton. At the time of my arrival the bonanza days were over and the ore-body showed indications of impoverishment.

Did the ore peter out?

It did not peter out; rather, it tapered out. The quartz continued, but it was not found profitable to work it.

Have you any explanation for the non-persistence of the rich ore?

The ore formation was an interesting and complex one, but difficult to describe briefly without diagrams, and I have no convincing explanation to advance as to the non-persistence of the rich ore.

El Callao served as a practical school of mining for a number of men, I believe. What others besides yourself?

Hamilton Smith made the first elaborate report on the property for the Rothschilds and came in such close touch with the local owners in Venezuela that he was made consulting engineer and brought about the Perkins management. Mr. Perkins had among his assistants Thomas Mein, who was his first mine-captain at El Callao, becoming later manager of the Nacupai, an adjoining mine. Captain Mein was afterward superintendent of the Alaska Treadwell mine; and then, in 1892, of the Robinson mine in South Africa, where he was much respected and beloved. Louis Seymour was at Callao in connection with the machinery of the 60-stamp mill and became one of Mr. Perkins' mechanical assistants. He was afterward mechanical engineer at De Beers, South Africa, then manager of the Fraser & Chalmers works at Erith, England, and again chief mechanical engineer to H. Eckstein & Company at Johannesburg. He was the organizer of the Pioneer Engineering Corps, which repaired bridges and other construction destroyed in the Boer war, and lost his life gallantly at Sand River.

Who else was there, Mr. Jennings?

George Webber succeeded me as manager in 1889 and

reduced operating costs to $10 per ton before his departure. He was manager afterward of the Crown Reef and then the Rand Mines in South Africa; and he, in turn, was succeeded by Barry Searls, who became manager of the Crown Deep Mines, at Johannesburg. M. Robeson acted for a time as mechanical engineer for the Nacupai and was also my mechanical engineer at El Callao. Subsequently he became assistant to Seymour at De Beers and on Seymour's death succeeded him as chief mechanical engineer to the Ecksteins. E. A. Blanton invented the cam now so well-known in stamp-milling while at the Union mine, in the El Callao district. Subsequently he became mechanical engineer at the Crown Reef mine. Robert Duncan, my foreman, became manager of the Alaska Treadwell mine. Richard Bowen became chief millwright to the Rand mines. John Walsh, the mill-foreman, was later mill-manager at the Ferreira mine. J. Klimke, later State Mining Engineer of the Transvaal, was a surveyor in the Callao district at the time of my arrival. I became acquainted with F. H. P. Creswell, of the Chile mine, who afterward became manager of the Village Main Reef and has attained prominence in political strife in South Africa.

I suppose El Callao furnished an experience in gold mining as good as could be obtained at that time?

Yes. The distance of Callao from sources of supply and the honest and progressive work there accomplished by men thrown so very much on their own resources, coupled with the command of large funds to install the best appliances, afforded a fine training.

What was the metallurgical process?

Simple amalgamation in stamp-mills. It did not pay us to ship concentrate. It was the simplest ore I have ever seen, some forty or fifty bags of specimen ore per month adding largely to the output. We used blankets and canvas tables for making a rough concentrate. Some of this was subjected to calcination or re-ground in pans or barrels with quicksilver.

How long did you remain at El Callao?

Two years. I had a two-year contract.

Your health was good all the time?

I was taken with fever two days after my arrival, but I had it in mild form. The doctor said, "You have the right fever and will never have the serious trouble that may come to people who have not been thus inoculated". My family, however, did not thrive, so they returned to New England pending my arrival. It's the everlasting heat that saps the energy of men in the tropics; the thermometer seldom went over 90°, but never below 70°. The humidity was excessive. The clearing of forest-lands and the system of housing and living at El Callao made it comparatively safe for white men. Most of those who were there during my time are still alive.

From El Callao you went to South Africa?

I first went to London, where I obtained an appointment with Jules Porges & Co., the predecessors of Wernher, Beit & Co. and the parent firm of H. Eckstein & Co. in South Africa. That was in 1889. I arrived on the Rand in December of that year.

What stage of development had the Rand reached at that time?

The first gold from the Witwatersrand conglomerate was panned in 1885. Johannesburg was founded in 1886. The first stamp-mill erected to treat the 'banket' was the Wemmer in 1887. At the time of my arrival the monthly output from the mines had reached 39,000 ounces and the total return for that year was £1,300,000. The mining laws of the Transvaal were liberal and definite. Feverish pegging of claims had taken place in all likely localities. Boom hopes and market quotations had soared high, but were on the wane; market depression had set in and continued for some three or four years, during which time much good constructive work was done. Not many mines showed a substantial net profit, in spite of high yields. No railway had then reached Johannesburg and the cost of working was extremely high, while extractions in the mill were painfully low. The workings were just entering the pyritic zone, for example, in the Percy and Jumpers mines. Everybody was anxious about the continuation of the deposit and was questioning the proper method of treating the pyritic ore.

At what depth was this pyritic ore intersected?

At between 50 and 250 ft. down. The average recovery at that time was not over 60%, but the tests that had been made showed that extraction by amalgamation was just about as good on the pyritic as on the oxidized ore.

What was there to supplement plate-amalgamation in the mills?

Only blankets. There was no systematic treatment of the concentrate. It was stored for future treatment. Several processes were being discussed—for instance, the Vautin, which was chlorination under pressure. The chief producing mines then were the Robinson, Crown Reef, Langlaagte Estate, Jumpers, and Durban Roodepoort.

How much were these mines producing?

There were about 40 mines with stamp-mills at work, averaging about 20 stamps per mine. The Robinson was the richest mine, with 40 stamps treating about 4000 tons per month, a yield of about £28,000, or £7 per ton. The Crown Reef, with 70 stamps, treated about 4800 tons, yielding only 33 shillings per ton. The Langlaagte Estate, with 70 stamps, was crushing about 6000 tons for a yield of 70s. per ton. The average yield for all the mines in December 1889 was 3900 oz. at 63s., or $15, per ton.

What was your position?

I was engaged as consulting engineer to H. Eckstein.

Can you give some facts about this firm and your connection with it?

The firm of H. Eskstein was a branch in Johannesburg of Jules Porges & Co. Julius Wernher was connected with Porges in diamond-mining at Kimberley as early as 1876. In 1884 they formed a close connection with Alfred Beit—a most fortunate combination. The latter became the Kimberley representative of the firm, while Wernher went to London. Beit had great intuition and imagination; Wernher had great sagacity and prudence. Beit was the valve-gear and Wernher the fly-wheel of the firm of Wernher-Beit, which took over the business of Jules Porges & Co. soon after my arrival in South Africa. Her-

mann Eckstein came to Kimberley before Beit was associated with Porges.

And Beit became the coadjutor of Rhodes?

Yes, Beit was a great believer in and friend of Cecil Rhodes, and without his aid it is doubtful if Rhodes could have accomplished the amalgamation of the diamond mines. At Kimberley these men were also thrown into contact with J. B. Taylor, Lionel Phillips, and George Rouliot, all of whom became members of the Eckstein firm and had dealings with J. B. Robinson. They became acquainted with American engineers in the sterling personalities of Gardner Williams and Louis Seymour. They were also friends of Dr. Jameson and of each other, for early experiences knit people together. Financed by the Porges firm, H. Eckstein and J. B. Taylor opened an office at Johannesburg in 1887 under the name of H. Eckstein, the title being changed to H. Eckstein & Co. after the death of Hermann Eckstein in 1893. Friedrich Eckstein joined them in 1888 and Lionel Phillips in 1889. George Rouliot, Percy Fitzpatrick, Raymond Schumacher, and others were given interests at considerably later dates. I received a cordial welcome from Taylor and Phillips, and a few months later a hearty one from the Ecksteins.

These must have been able men?

Indeed they were. Hermann Eckstein was made the first president of the Chamber of Mines in 1890. Besides being a keen man of business, he was most generous and kind-hearted. The Ecksteins were sons of a Lutheran clergyman and were born at Stuttgart, South Germany. Hermann Eckstein's death in 1893 was a great loss to the Rand. Subsequently, Friedrich Eckstein took a prominent part in the business. He is fortunately still alive and has much of his brother's ability and kindliness. Both Taylor and Phillips have won distinction, and remain close and loyal friends.

How did the firm of Wernher, Beit & Co. acquire its big control?

In 1886 Beit financed J. B. Robinson in his purchases of farms on the Rand and in return the firm received large holdings in the Robinson, Langlaagte, and Randfontein properties, but they so traded that their holdings in the Robinson mine became

the dominant one. Besides interests in the above mines at the time of my arrival they controlled the management of the Ferreira mine, then in the equipment stage, and had large holdings in the Crown Reef, Jumpers, and Bantjes, and considerable 'deep-level' ground. They made big profits in the boom of 1888-1889, but as they believed in the future of the goldfield, they were desirous of giving the mines with which they were connected every advantage that science and money could furnish. They endeavored to place the high capitalization due to the boom on a solid basis of actual returns. They took all risks in initial stages and floated no companies that had not intrinsic promise. They asked no reports from their technical staff for flotation or stock-market purposes. They encouraged the collection of statistical information, which was given freely to the public to an extent not known elsewhere in the mining world. The returns from the mines were given under oath. They trusted fully and rewarded liberally those that won their confidence and approval. I consider it a rare good fortune to have been thrown with these men as I was, and to recall my pleasant and cordial relations with the original members of this firm, which continued for 16 years without rupture except by death. The untimely deaths of Hermann Eckstein in 1893, Beit in 1906, and Wernher in 1912, robbed me not only of honorable, powerful, interesting business associates, but also of kindly loyal friends.

The initial success at the Robinson and the Ferreira encouraged them to obtain controlling interests at low prices in languishing mines or those on which work had been suspended, such as the Crown Reef, New Heriot, City & Suburban, Village Main Reef, Salisbury, Henry Nourse, New Modderfontein, Nigel, besides deep-level companies, etc., for all of which I acted as consulting engineer, as well as for the Robinson. By liberal financing and good management these were placed on a most prosperous basis.

The fruit of their policies is seen from the returns of the Eckstein group of mines in 1911 prior to the death of Sir Julius Wernher. The output of the Rand for that year was approximately £34,000,000 from about 24,000,000 tons crushed, of which over £12,000,000 was produced by the Eckstein group, crushing nearly 9,000,000 tons. The men employed during this year

numbered about 25,000 white and 190,000 natives, or more than is employed in all the gold, silver, copper, lead, and zinc mines in this country. The Eckstein group worked about 8000 white and 56,000 natives, and earned over 40% of the dividends declared.

What were your first impressions of the Rand?

I went to the Rand with little knowledge of the work already done and with no preconceived ideas as to how it should be done. My brother, Sidney, came out with me, but he went to the Willows silver mine near Pretoria, then to Kimberley, and did not enter gold mining until 1893. I brought with me no assistants, but soon obtained the efficient aid of Arthur Wilkinson, the secretary of Eckstein, also of Fernside Irvine, a Scotch mechanical engineer, John A. Dennison, a young Englishman, also Hugh F. Marriott, a graduate of the Royal School of Mines, who did excellent work in connection with the early boreholes. I realized at once that the Rand presented conditions different from any that had theretofore occurred in my experience or reading, and I was frank enough to beg for time to educate myself on the spot. I did not attempt a comprehensive report of my views until March 1890. The report was conservative. It gave warning as to boom values, but showed confidence in the future of the goldfield; it advised that profits should be moderately estimated and carefully striven for. Time was taken to convince myself and then my principles that it was right and necessary to spend largely in order to reap bountifully, but this was soon done fearlessly on a great scale.

What metallurgical advice did you give?

At that time nobody realized the great downward continuation of the ore, nor did we know how best to extract the gold. I knew, and others knew, that by increasing the number of Frue vanners such as were used in the Robinson mill, and by using more blankets, we could increase the extraction. This was done, and it was also decided to treat the concentrate by chlorination.

Was that when Charles Butters was engaged?

Yes. I had known Butters in California, and he was also known to the other Californians, so a telegram was sent to Perkins, who offered him an engagement.

When Mr. Butters arrived you proceeded to erect a chlorination plant at the Robinson, I presume?

Yes, and that plant eventually proved successful. Before its construction James A. MacArthur, J. H. Cordner-James, and Alfred James came to the Rand and gave us an opportunity to test the now famous MacArthur-Forrest process of cyanidation. Alfred James took a leading part. The first test-plant was erected at the Salisbury mine in 1890. As a representative of the Ecksteins, I was given the first opportunity to ascertain the efficiency of the process.

What plant did they have?

They agitated with paddles in tanks, but on a small scale. The plant gave no opportunity of determining the cost of working on a large scale, but it did afford facilities for determining the extraction. I watched the work with my assistant, from the charging of the tanks to the final clean-up, and was much impressed with the result.

That was an historic occasion, Mr. Jennings?

Yes, indeed. I had the opportunity of being thrown into intimate contact with MacArthur and Alfred James. MacArthur was a most modest man, and impressed me with his quiet ability. The only claim he made for his part in the discovery of the process was that he had suggested the means of precipitating the gold. The idea had occurred to him through seeing workmen making shavings from a big plate of zinc. He conceived the idea of using zinc shavings in a compact form instead of precipitating on a big plate-area. Thus he made the process practicable. Of course, the theoretical knowledge of the solution of gold by cyanide and the precipitation of the gold on zinc were matters of encyclopedic record. MacArthur's adoption of the use of dilute solutions was the key to the usefulness of the process.

What did the people on the Rand think of it?

The fact that the cost was not given prevented the companies on the Rand from adopting it at once. I found out afterward that the extractions obtained in the initial test were confirmed by practice on a large scale. At that time MacArthur was aware of the need of fine grinding in the obtaining of high

extractions. The cost of these early experiments must have been over 30 shillings per ton, so that it was no wonder the owners of the patents were desirous of keeping them secret, and it was this high cost that caused MacArthur and his friends to discard arranged.

Did your firm make any arrangements with them?

Yes. Eckstein & Co. expressed willingness to have the accumulation of tailing treated on a sliding scale by the owners of the process, provided the firm was afterward given the right to work the process itself at a minimum royalty. This was duly arranged.

Who built the first cyanide plant?

The first cyanide plant on the Robinson mine was designed by Alfred James and MacArthur, and in that plant all the fundamental principles now to be seen in modern practice were in evidence. Of course, subsequent work has immensely improved the details and lowered the cost. This plant was placed in charge of G. A. Darling, one of the men brought out by MacArthur. That was in 1891 and 1892, after which the Robinson company took over the plant and started a larger reduction works, the designing of which was given to Charles Butters, who had shown such skill and energy in connection with the erection of the chlorination plant. Mr. Butters was limited in the size of his tanks to the maximum then known to be successful in operation, namely, a diameter of 23 feet. He introduced the bottom discharge.

What was the position of Alfred James in this business?

He was the brother of Cordner-James, who had the patent rights in South Africa with Webster. Alfred James was associated with the Cassel company—as was MacArthur—and he was a great factor in the designing and starting of the Robinson plant, which may be said to have been the first large cyanide plant erected on the Rand.

This first plant was for the treatment of accumulated tailing from the ore mined in the oxidized zone. Did not the oxidation interfere with the cyanidation?

Certainly it did. The acid had to be neutralized with lime. In the extraction given by MacArthur it was shown that pyritic concentrate as well as tailing could be treated successfully, and one of the first plants to do this was that at the Nigel mine.

Who was the metallurgist or manager of the Nigel?

Richard Gluyas was the manager, but the plant was erected and for a time run under the direction of my assistant, Fernside Irvine.

What about the direct filling of the tailing into the cyanide vats?

The first attempt, which was under my guidance, to accomplish the continuous treatment of the product from the stamp-mill was made in 1893 at the Salisbury mine, where square wooden tanks were used in connection with an hydraulic classifier that separated the slime from sand. The practical success of the method was only demonstrated later at the New Heriot and Nigel plants with round tanks under the control of W. K. Betty and Fernside Irvine. J. Harry Johns, of the Ferreira, a Cornishman, and a graduate of the Royal School of Mines, was a co-worker and friend, and lent me aid in this and other work during my stay in South Africa. The method was adopted finally at all the mines, an improvement over the original hose-filling of the tanks being made by the Mein-Butters distributer.

Did you use concrete or cement vats?

The first tanks of great diameter—40-ft.—were constructed at the Langlaagte Estate under the direction of George Richards, manager, and John R. Williams, metallurgist. The latter afterward had charge of the square concrete cyanide-tank plant at the Crown Reef and made the first successful treatment of slime by the decantation process there. He was also for some years directing metallurgist for the Eckstein group of mines. Square concrete cyanide tanks were also erected at the City & Suburban mine.

What other metallurgists can you mention?

In the metallurgical department of our firm were two other men who came out with Alfred James and MacArthur, namely, W. K. Betty and S. H. Pearce. They were prominent in the subsequent development of the cyanide process, Betty introducing an

effective method of increasing or stimulating the extraction in the zinc-boxes. Fernside Irvine, my assistant in the firm's mechanical department, became also most proficient in cyanide construction work. Alfred L. Simon was another able chemist employed by us who experimented with the Malloy sodium-amalgam process. William Bettel came out for the Willows Silver company and worked for some years at the Robinson. W. W. Mein took charge of the chlorination work shortly after Butters left the Robinson employ. Some other well-known chemists on the Rand, but not with my firm, during my stay there, were Andrew F. Crosse, W. R. Feldtmann, A. von Gernet, and H. F. Julian.

My understanding, Mr. Jennings, is that you were one of the first to introduce electric power on the Rand?

No, I do not think it quite accurate to say "first", but the new plant that I designed at the Crown Reef mine used electrical appliances more extensively than any other mine at that time on the Rand. Besides large underground and surface return-water pumps, the tramming from the mine to the mill was done electrically, and small motors were used in various ways. In this work I had the enthusiastic co-operation and assistance of Herbert Davis, the electrician, and the loyal energy and hearty co-operation of the general manager, George E. Webber, who had followed me to South Africa from El Callao, and who afterward became general manager of the Rand Mines.

Mr. Jennings, I would like to ask you about the deeper development of the Rand. When did you realize that the Main Reef series would persist to a great depth?

The persistent optimist in regard to the continuance of the ore in depth was Alfred Beit.

But surely Beit's optimism was founded on the advice of some engineer?

Yes. The first exponent of this belief was J. S. Curtis, at the Village Main Reef, where, in 1890, the depth of the banket was proved by a bore-hole to 530 ft. The piece of banket pierced by the bore is now on view at the Exposition. The Rand Victoria bore-hole was sunk in 1893 and proved the continuity of the ore to a depth of 2300 ft. The Bezuidenville hole intersected the

South Reef in 1895 at a depth of 3100 ft., the Turf Club hole in 1901 intersected it at 4800 ft. In this diamond-drilling I received valuable assistance from Marriott. In the deep bore-hole in the Turf Club ground we used his ingenious device for indicating the diversion of the bore from the straight line, and were astonished at the extent of the deviation. All this drilling proved unmistakably that the southern strata of the Main Reef system are continuous wherever observed, and with them the gold-bearing banket. It showed also the tendency of the lode to flatten, and made it possible to lay out plans for future workings.

In other words, you were able to foresee the change of dip on the evidences of a synclinal structure?

This was known to me and to many other engineers, but it was first estimated closely by Hamilton Smith during his visit in 1892. The estimate that he then made of the value of gold in the banket to a depth of 3000 ft., and for only the richest section, of 11 miles, was £350,000,000. This, considering all the circumstances, was a bold and far-sighted prediction, although under the mark, as the goldfield from 1887 to June 1915 produced £435,000,000. He wrote an article on this subject for the 'Times' and that, no doubt, did a great deal to establish public confidence.

When it became apparent that the lode would persist, your firm formed a consolidation called 'The Rand Mines', did it not?

The Rand Mines as a corporation was not formed until 1892. Interest in considerable deep ground on the dip from the richest mines had been secured by my firm prior to my arrival. At that time the public had lost faith in deep-level schemes and some were abandoned. After my arrival large areas farther on the dip were either purchased at low prices, pegged out, or acquired by amalgamation. In this way some 1700 claims, or about 2000 acres of ground, was obtained that commanded the dip in the choicest districts of the Rand, and at moderate depths. The capitalization of £400,000 represented only the cost-price of the ground, without equipment. Prior to the arrival of Mr. Perkins in 1893 I acted as consulting engineer and laid out some of the first shaft-work. Mr. Perkins was given full control, and under his administration, lasting some three or four years, nine subsidiary companies were either started, developed, or partly equipped, namely, the Glen, Rose, Geldenhuis, Jumpers, Nourse, Ferreira,

Crown, Langlaagte, and Durban Roodeport 'deeps'. Under his direction the first great advance in the speed of shaft-sinking was made, but was afterward exceeded by the Gold Fields group when more than 200 ft. per month was sunk in some of their large shafts. His construction work was done with despatch and economy, but he left the Rand after the Jameson Raid and saw only the Geldenhuis Deep started.

But, if I remember correctly, the Geldenhuis Deep was something of a frost?

I suppose it was. Considerable disappointment was first experienced in the Geldenhuis Deep, owing to difficulties in cyanide work, and also in the yield, but in the end, through Mr. Webber's efforts and more extended development work, the mine was brought to a successful issue, as is shown by the records. Ultimately the mines I have mentioned were developed and equipped on a scale demanding an outlay of six or seven millions sterling, working 1300 stamps and crushing nearly 2,500,000 tons per annum, yielding over £4,000,000 per annum.

Now, Mr. Jennings, I am going to ask you a delicate question. Do you believe that the ore, that is to say, the banket containing enough gold to be profitably exploited, will persist to a uniform depth on the Rand of, say, 5000 ft.? Do you not conclude that the evidence already available indicates that the Main Reef series is becoming poorer in depth?

That, of course, is a most difficult as well as a delicate question, especially as I have not been on the Rand for more than 12 years. Statistics plainly show the falling off in yield from the early to the later years, the average dropping from 42 shillings per ton in 1890 to 27 shillings in 1914. This certainly puts up danger signals, and while there is no doubt that the ore near the surface was richer than that at any considerable depth, yet selective mining was rightly and naturally done in opening out properties under adverse economical conditions. The reduction of working costs justifies the mining of more and more low-grade ore, so it becomes difficult to state whether the falling off is due to improverishment in depth or to less selective mining of the ore, or to both. The greater the number of stamps erected, the more temptation there is to work some unprofitable low-grade ore to keep them going.

From the deepest shafts and bore-holes it is evident that there is some profitable ore at a depth below 5000 ft. and before the exhaustion of the goldfield it is probable that the average working cost will be very materially reduced, and thus will allow even leaner ore to be worked. The water in the deepest workings does not present a serious problem; pumping and winding machinery has been so perfected that in this department low cost even at great depth can be looked for. But, even as Methuselah died, so also must the Rand, and if it survives a decreasing yield, then increasing temperatures and numbers of stamps must drive out workmen and wear down the present deposit so that in twenty or thirty years there will be little left to exploit at large profit.

Can you tell me anything about the starting of technical societies on the Rand?

The first technical society on the Rand was the South African Association of Engineers and Architects, formed in 1892, of which I had the honor of being first president: S. J. Farrar and A. H. Reed, were vice-presidents, E. P. Rathbone, treasurer and secretary, J. S. Curtis, T. Reunert, C. Aburrow, and G. R. Andrews, members of council. It was started in a modest way, but finally developed into an important society and the title changed in the year 1898 to South African Association of Engineers, as less than 10% were architects. Under its auspices Behr's paper on 'Winding from Great Depths' was brought out and discussed in such an intensive way that it finally resulted in a special volume in the proceedings of the Institution of Mining and Metallurgy in London.

In addition to this society there was formed in 1894 the Chemical and Metallurgical Society of South Africa, of which the early presidents were William Bettel, Andrew F. Crosse, W. R. Feldtmann, John R. Williams, and Charles Butters. This society was very much of a live wire and had much to do with the development of the cyanide process, as in its proceedings many papers on the various details of this process were presented and most energetically and candidly discussed.

I believe these societies have been instrumental in stimulating and extending the usefulness and advancement of technology. Their early meetings were animated, they brought the technical

men of the Rand in closer touch, and made their work and characters known to each other and to the world.

What were the first steps taken in technical education in South Africa?

Nothing was done under Boer rule in the Transvaal in this connection, but a good start was made in 1896 in a divided course at Cape Town and Kimberley. The War interfered with this work, and after the War the school was consolidated with one started at Johannesburg about 1904. The one at Johannesburg had its rise in the interest Lord Milner took in technical educational matters in the Transvaal and the formation by him of committees and commissions to look into the feasibility of starting such institutions. The first committee, of which I was a member, was formed in 1902. I was also associated with Professor Henry Miers—now Sir Henry Miers of London University—in an advisory capacity. Night-schools were started and work was done on a small scale. Prof. James G. Lawn of the Kimberley School initiated some of the earlier work. Prof. Hele Shaw, of the University of Liverpool, was sent out in 1904 or 1905. The school gradually expanded in temporary quarters, but the grants of a building-site by the Government permitted the erection in 1909 on Plein Square of an imposing building costing $300,000, equipped with all up-to-date laboratory appliances. In this building is housed the Seymour Memorial Library, with an endowment of $50,000. A hall of residence, Sunnyside, is provided for the Dean and students in the suburbs, and it is interesting to me to remember that besides serving as a residence of the High Commissioners, it was, before its enlargement, my home. This institution is now able to give valuable mining technical instruction in connection with access to the various mines.

What were the relations of the American engineers to those from other countries?

In 1887 the total gold output of the world was about $107,000,000, while for 1914 the output of the Rand alone was in the neighborhood of $165,000,000, and of the world, $455,000,000. This phenomenal advance in the local industry brought in its train an urgent need for men from abroad experienced and trained in gold mining. This statement on its face also demonstrates the

necessity for cultivating and advancing local talent. The Rand attracted engineers from all over the world. The American engineer was favored in the start through Hamilton Smith and H. C. Perkins, who were connected with the Rothschilds and who were also in touch with H. Eckstein & Co. and the De Beers Co. Through them Gardner Williams and Louis Seymour came to Kimberley, where the leading Johannesburg capitalists had their start, and myself and others to the Rand.

The English engineers, managers, and technical men were early on the spot and were strongly represented by such men as Sydney J. Farrar, J. Harry Johns, Fernside Irvine, Theodore Reunert, O. Lentz, C. J. Alford, J. Herbert Davis, Edgar P. Rathbone, E. J. Way, George Richards, G. A. Goodwin, H. R. Skinner, J. M. MacFarlane, Laurie Hamilton, F. Spencer, C. Rowe, A. R. Sawyer, K. D. Griffiths, E. H. Melville, G. R. Andrews, and later by Hugh Marriott, R. J. Frecheville, S. J. Speak, Stanley Clay, F. H. Hatch, S. J. Truscott, S. Hancock, David Gilmour, Kenneth Austin, E. F. Laschenger, and W. H. Wood. I must not omit the name of F. Raleigh, the secretary of the Crown Reef and afterward chief assistant to Mr. Webber. J. H. Curle was millman at the Nigel for a time while I was consulting engineer.

The Eckstein firm was instrumental in bringing to the Transvaal a large number of American technical men, among whom in earlier years were (in this list of names those arriving after 1903 are not included): 1887, J. S. Curtis; 1889, Sidney J. Jennings; 1890, Charles Butters, Joe Richard, John Walsh; 1891-2, Thomas Mein, O. H. Hahn, R. H. Harlan, W. W. Mein; 1893-4, H. C. Perkins, George E. Webber, E. A. Blanton, G. B. Poore, Richard E. Bowen; 1895, W. H. Hall, Eugene Hoefer, Palmer Carter, and Lane Carter; 1896, Louis Seymour, J. S. Price, W. Bradford, and later, H. S. Stark, R. C. Warriner, and Maurice Robeson.

John Hays Hammond came out in 1893 for the Barnatos. He soon changed to the Gold Fields group and introduced a number of Americans, among whom were George Starr, for the Barnatos, and Victor Clement, Pope Yeatman, H. H. Webb, R. V. Catlin, H. C. Behr, and Ernest Wiltsee for the Gold Fields.

The Neumann group obtained in T. H. Leggett and F. Hell-

mann two other prominent American engineers, and George F. Becker, of the U. S. Geological Survey, made for them a geological report.

There were not many engineers of other nationalities: notable among these were J. Klimke, a Hollander, State Mining Engineer, R. N. Kotze, also State Engineer, a native of the Transvaal, H. Islin, Swiss, Schmitz Dumont, L. De Launay, a professor of the Ecole des Mines who wrote a treatise on the mines after his visit, as did Bergrath Schmeiser, a German government engineer.

Good relations existed between these men of divers nationalities?

In the early years there was plenty of work for all who came to the Rand with good technical experience, and therefore most cordial relations existed between the different technical men. The great influx of Americans was most generously received and treated by their English kinsmen. Certainly, I have reason to acknowledge the great kindness extended to me by them in both the Transvaal and London.

It was self-evident that it was wasteful, and soon impossible, to continue indefinitely the importation of expert talent from abroad, and that the natural and right thing was to train the younger men while advancing the older ones that had demonstrated their ability. The sending of Royal School of Mines students from London and the founding of technical teaching in the Transvaal was certainly a right step for student-training schools. Many of these showed exceptional talent, and it was a pleasure to advance them. At the time of my leaving I was gratified to see what able managers had been developed on the Rand. In consequence of this policy the American engineers who returned to their own country were not replaced by new importations, and thus, at the present time, the number of American engineers on the Rand is far smaller than it was ten or twelve years ago. It is gratifying, however, to look back on the work done by Americans and see how they have done their full share in bringing about the great achievements of the Rand. Any impression that the American technical men did it *all* must be set aside. Taking all the names previously mentioned, it would be quite impossible, impolitic, and presumptuous to attempt in any way to adjudicate individual praise to the engineers, managers, and technical men

cited. The results and history of the greatest goldfield in the world, more eloquently than any comment from me, speak for them.

I would like to ask you if you think the Rand is a good training-school for other mining regions. Do not the relative uniformity of the ore and the big scale of operations militate against the engineer's usefulness in districts where these conditions do not obtain?

The Rand has been a very limited school of late years for giving initiative in the investigation of new properties. Current methods in the Transvaal have been standardized by the great similarity of the problems to be solved at the various mines; however, it did and should still present a splendid field for experience in the handling of men and material on a large scale, and also in administration.

How about the Chinese experiment? Do you think that the introduction of the coolies was a wise step?

There were none in the Transvaal at the time I was there, but from reliable information I infer that it marked an advance in the application of low-grade labor. Even at a higher wage, the work of the Chinese averaged better than that of the Kaffir or native black African.

In other words, you consider that it was a pity that the importation of Chinese was stopped?

I do, on economic lines; and I see no moral ground why this scheme should have been abandoned.

When did you leave the Rand?

I left with my family in 1898 and went into the London office of Wernher, Beit & Co. of which H. Eckstein & Co. was a branch. After the War I returned in 1902 and spent a year in aiding in the reorganization of the mines. My brother Sidney was then acting consulting engineer of the firm.

Did you find the work after the War interesting?

Most intensely so, as Lord Milner had initiated new constructive ideals and methods in all branches of civic life in Johannesburg. The mines had to be valued under new conditions and

more broad and permanent lines laid down for their working. The deep-level problem had to be re-adjusted on a bigger-unit basis and in this connection the discussion, in which I took part, on winding from great depths, was most educating. Taxation and new political problems had to be met and technical educational matters were initiated, as I have already described. A descriptive and statistical statement of the gold-mining industry of the Witwatersrand was compiled and prepared by the engineers of the various groups of companies for Joseph Chamberlain, Secretary of the Colonies, who visited Johannesburg in January 1903. The committee of 15 engineers who drew up this report are as under: Hennen Jennings, chairman; G. A. Denny, F. H. Hatch, F. Hellmann, G. J. Hoffmann, W. L. Honnold, S. J. Jennings, J. H. Johns, R. N. Kotze, S. C. Thompson, H. R. Skinner, H. H. Webb, G. E. Webber, P. Yeatman, and F. J. Carpenter, secretary.

We went thoroughly into the past history of the goldfield; the yields, working costs, and statistics of past workings; the probable number of stamps that might be required in the future; the wages, living expenses, and relative proportion of natives and white men to bring about the best results in the future. It is interesting, in looking over this most exhaustive report with its tabular statements, to see how closely the future has established some of the predictions made therein. The statistical information was gathered and put together in a short time and it was only made possible by the whole-hearted co-operation of the engineers and the companies they represented.

You were in South Africa at the time of the Jameson Raid. How did it affect you?

I shall not pretend to take up the causes and happenings of the Raid, which has been the subject of so much writing. I can only say that I had the rare good fortune to keep out of jail and yet to hold the respect and esteem of my friends in it. After the Raid an effort was made to bring the necessities of the mines before the Government, and an Industrial Commission of Inquiry was appointed by the Government for this purpose with Schalk W. Burger as chairman. The Commission investigated matters most thoroughly, some 33 owners, engineers, managers, railwaymen, etc., being called as witnesses. I took great interest in this

work, and gave direct and cross-examination testimony extending over some three days, during which I attempted to summarize the history and statistics of the mining industry to that date. Although the report of the Commission was broad-minded and favorable to the mining industry, it was not thoroughly acted upon by the Government. The Jameson Raid started ill-feeling among the Boers, and this was fostered by their unrestricted importation of arms for three years, which of necessity meant war, as I realized before my departure.

After returning to London, on your leaving the Rand again, how long did you remain in England?

I remained with the firm until my departure to the United States in 1905, in the interim, however, making a visit to the El Oro district in Mexico. While in the London office I had many new propositions brought to my attention.

I remember you took a prominent part in the reorganization of the Royal School of Mines, and the development of mining education in London. You received the gold medal of the Institution of Mining and Metallurgy for your services in this regard, did you not?

The medal was not given me alone for my work in connection with technical education, but also for my connection with the mining industry in South Africa. In fact, the award was made before I had an opportunity of completing my work on the Departmental Committee of the Royal College of Science, but it is a generous and valued tribute from my English confreres. I received the appointment to serve on this committee in virtue of my being President of the Institution of Mining and Metallurgy in London at the time when the committee was created. My departure for the United States was made, as stated above, before I could complete my work, but our good friend Walter McDermot took my place. I consider it a great privilege to have served on this committee and believe it would have been a valuable object lesson to some of our Government committees to have seen the dignity of the proceedings, and the impartial way in which the questions were rotated to the different members of the committee and the varied lines of facts and thoughts evolved.

I believe that since your return you have, among other things, taken care of the McKay bequest to Harvard.

Yes, I have been connected with the Conrey Placer Mining Co., which started in 1898, operating in Montana, where there is now a fleet of four dredges at work, one as large as any in the world, namely, 16-cu. ft. buckets, 550-hp. digging-motor, and a 100-ton washing-trommel. This dredge in one month has dug as much as 411,000 cu. yd. from a depth of 54 ft. The dredge was evolved by a system of progressive development in dredging practice of which the early dredges started by Shaler were daring and useful pioneers. Gordon McKay, well known as a capitalist and inventor of leather-working machinery, in the initial stages of the enterprise advanced the greater part of the working capital and controlled the company. He took a keen interest in all the mechanical details of the dredges. A centrifugal pump designed by him has been worked with success and economy on several Conrey dredges.

Professor Shaler, Dean of the Scientific Department in Harvard University, acted as consulting engineer and president until the time of his death in 1906. He was active in all the affairs of the company and his geological attainments were valuable in the purchase of properties. He was also instrumental in bringing electrical power to the property. This venture brought McKay and Shaler in close contact and knitted their friendship. At his death Gordon McKay willed almost his entire estate to the Scientific Department of Harvard University, but in a circuitous way, so that the University only obtains the full income by degrees. His very large interests in the Conrey company have given his estate, through dividends, retirement of stock, and interest on notes, something over $1,000,000, which should eventually enrich the Harvard Scientific Department by this amount, and should be further swelled by the future earnings of the company

I understand that you are taking a great interest in the Pan-American Scientific Congress. What is it exactly?

This is the second Pan-American Congress, the first having been held at Santiago, Chile, in 1908. The present Congress was convened by Mr. Bryan, when Secretary of State, and is under the auspices of the State Department. The purpose is to bring together in friendly and cordial manner scientific men and societies

of North and South America. An appropriation of $50,000 has been voted by Congress for the right entertainment and legitimate expenses, but this will probably not be sufficient for the publication of the papers, of which there should be a great number, and valuable. There have been a number of acceptances from South America and the Congress promises to be a large and important one.

You do not concern yourselves with the development of business relations between the Americas?

The Congress will be divided into about nine divisions, with separate chairmen. I am chairman of the Mining, Metallurgical, Economic Geology, and Applied Chemistry sections. While we have nothing in particular to do with business, we believe that the exchange of ideas will tend that way. The very fact that mining and metallurgy are fundamental industries will necessarily help business if they are advanced.

Mr. Jennings, may I ask you, did you participate in the profits of the mines with which you were connected?

Yes. In the latter years of my connection I had a definite participation in profits. My firm always encouraged me to invest in anything of intristic value with which I was connected. In this way I was able to make some fortunate investments, as I have never bought stock that I did not believe was worth more than I was paying for it, and I never bought more than I could pay for.

Do you approve of mining engineers speculating in mining shares?

I certainly do not believe in mining engineers or anybody buying mining shares on margin. An engineer, especially in his early career, should not lay himself open to criticism by having holdings unknown to the public in properties on which he is reporting.

Do you believe that the buying and selling of shares outright in any mine is apt to vitiate the judgment of an engineer?

Yes, I do, in the ordinary way of dealing in shares. In fact, I believe the Stock Exchange is a curse rather than a blessing to the mining industry. However, in working a property not quoted on the Stock Exchange, there is no reason why an engineer

should not back his belief by putting his money alongside that of the owner.

You have had an unusually successful and honorable career; can you analyze the reason for your success?

I remember very well what Hamilton Smith said to me at the New Almaden mine when I was offered a salary of only $50 per month without board. He said: "Do not mind this salary, Hennen; do not think of your salary, but of your work, and one of these days you will be paid more than you are worth". Whatever success I have had has not been due to the possession of any particularly brilliant brain, but to hard work with interest in it, and to coming into kindly contact with men about me, and in obtaining their assistance in the work I was directing.

THE STORY OF A CAREER

*In this issue we publish an interview with that distinguished mining engineer, Mr. Hennen Jennings. For the length of this interview we offer no apology. Those who read it will realize that none is necessary. "The proper study of mankind is man." Nothing can exceed in human interest the story of an honorable career when told by an engineer to engineers. The contemporaries of the man interviewed will be keen to read what he has to say about his own doings and quick to appreciate his friendly mention of themselves. We find, on counting, that Mr. Jennings makes mention of 130 persons with whom he has been, at various times, brought in contact. Moreover, the younger men, to whom the subject of the interview is known only as an outstanding personality, will discover in the recital of his experience a wealth of suggestion and stimulus.

We find much on which friendly comment could be made. Mr. Jennings is one of hundreds to whom Shaler was a friend in trouble and a guide to success. Surely the gift of friendship that Shaler gave to so many young men during his long professorship at Harvard will continue to exercise its vibrant impression long after his lectures and poems are forgotten. But Shaler was only one of many notable personalities at the Cam-

*Editorial in the 'Mining and Scientific Press' of December 25, 1915.

bridge of forty years ago. The magnetic touch of such men might well be felt for many years after the Harvard graduate had gone forth into the arena of life. New Almaden and El Callao afforded excellent training for the bigger work of Mr. Jennings in South Africa. The account of the introduction of the cyanide process on the Rand is particularly interesting. Evidently the discovery of zinc shaving as a precipitant for the gold was the first step in the practical success of the process. The next big event was the deep-level exploration of the banket seams, for which Mr. J. S. Curtis is given proper credit. He will be known best to Western miners as the author of the Eureka monograph. As will be seen, we ventured to put a delicate interrogatory in regard to the persistence of ore in depth and received a characteristically circumspect reply; yet, reading between the lines, it can be inferred safely that Mr. Jennings recognizes the inescapable reality, for, among other hints, he makes reference to the fact that even Methuselah found, as Voltaire said, that *"la vie, c'est une maladie mortelle"*. Perhaps Mr. Jennings had in mind an editorial that we wrote, in another place, 12 years ago, when the South African promoters, and engineers, were talking a little too exuberantly about sinking shafts to a depth of 8000 feet, to cut the Main Reef series at 18,000 feet on the dip. Well, 'Even Methuselah died' is not an unfitting epitaph on those iridescent dreams of unwearying persistence. The son of Enoch shows signs of 'handing in his checks'. However, let "the dead past bury its dead". Another and easier question to answer concerned the international components of the engineering fraternity on the Rand and the harmonious relations subsisting between them. We can understand readily that Mr. Jennings himself would ignore provincialisms of any kind, for we know how, in return, he won the personal regard of the English engineers, as is proved by his election twice to the presidency of the Institution of Mining and Metallurgy—perhaps the most signal honor out of many that he has won.

Indeed, it is a fine profession that can be typified by such a man as this. From a little town on the Ohio river to the capitals of Europe and America he followed his destiny, serving his apprenticeship in California, gathering basic experience in Venezuela, and applying a rare sagacity amid the delirious developments of the greatest goldfield in the world, the Witwatersrand,

that 'white waters range' in the Transvaal where the biggest natural depository of precious metal in human history was uncovered by the mining engineer. Throughout the maze of circumstance we see the directing force of a strong character. Not quick to make decisions, not flashy in the expression of his mind, lacking the intuitions of nimbler brains, Mr. Jennings won respect and esteem for his poise, for soundness of judgment, and a rare balance of mind that proved of inestimable value to his famous clients at a time when they were developing the resources of a continent and engaging themselves in speculations of gigantic dimensions. If Alfred Beit was the piston, and Julius Wernher the fly-wheel of that notable partnership, it is clear that Hennen Jennings was the governor that regulated the safe motions of a great financial and industrial mechanism. For ourselves, we like best of all his own summary of his career and the discriminating appraisal of a fine achievement. To his friends, the last paragraph will seem characteristically modest; to the younger men it conveys the clear lesson that little of enduring value can be achieved without co-operation, the ability to enlist the sympathetic help of others, the unselfishness to give them credit for such help, and the consistent capacity for taking pains that surmounts all obstacles.

THOMAS H. LEGGETT

AN INTERVIEW

You are a New Englander, Mr. Leggett, are you not?

A New Yorker, born at Flushing, Long Island, in 1859.

Therefore, you naturally went to the Columbia School of Mines?

Yes, after going through the introductory and freshman years of the College of the City of New York, I graduated in the class of '79 at Columbia.

What part of your training do you consider has proved of the greatest benefit to you in your career as a mining engineer?

The mathematical course, under Professor Van Amringe, and the chemical course under Dr. Chandler. It so happened that during my time the mining course was in process of reorganization under Professor Trowbridge, while Professors Hutton and Munroe were just starting as Adjunct-Professors. The summer school of practical mining, which Professor Munroe inaugurated with the class of '78, was of immense benefit.

What was your first employment?

As rod-man at $2 per day in river and harbor surveying under General Newton, famous for clearing the East River of Hell Gate reef by dynamite. It enabled me to get my first experience in coast-surveying and later to take charge of a surveying party.

Where was this?

Along the rivers and harbors round about New York City and its vicinity, Long Island and New Jersey.

What was your first work in actual mining?

After the surveying in '79 and '80, I was assistant at an iron blast-furnace on the Hudson river, and there obtained my

first experience in metallurgy, also in book-keeping—and I am inclined to think the latter did me quite as much good as the metallurgy. When the boom in iron collapsed I was given an engagement in Mexico, on the staff of the Batopilas mines, in the state of Chihuahua. These mines were controlled by Alexander R. Shepherd, more familiarly known as 'Boss Shepherd' on account of his political career at Washington, he being the first and last Governor of the District of Columbia. His methods of cleaning up the old town were drastic, but they were most effective, and on his re-visiting Washington in '86 the city showed public appreciation of what he had accomplished.

What route did you take to Chihuahua?

I went through Denver, about Christmas time in 1880, and meeting Theodore Schwartz I obtained through him the opportunity of seeing the gold mines of Georgetown and Black Hawk before proceeding to Mexico. I went by train as far as Mesilla, at that time the construction end of the Atchison railroad, and staged 40 miles into El Paso, which town was so crowded that I was thankful for a cot, four in a room, in a little adobe hotel—by courtesy. Then we went by stage to the city of Chihuahua, a six-day trip on account of the snow, thence on mule-back for another six days across the Sierra Madre to Batopilas.

In those days the Indians were still on the war-path?

Victorio and his Apaches were very active, and I remember we sat in the stage-coach with our rifles across our knees most of the way, not that they would have done us much good, but more for the moral effect. I remember the stage being stopped at 10 o'clock one night as we were approaching the end of the day's run, by a Mexican on horseback, who stated that a little way ahead and on the same high-road there had been found the dead body of a Mexican still warm; he wished us to carry the news into the town we were then approaching, and inform the proper authorities by telegram. It was an unpleasant evidence of the nearness of the Apaches.

The Batopilas is a silver district, is it not?

The ore is valuable for its native silver. At that time they were just starting a 15-stamp mill equipped with Frue vanners,

amalgamating pans, and settlers to treat the lower-grade ores that always accompanied the rich native masses, but in variable quantity, and carrying pyrite, blende, and galena as accessory minerals. These 'sulphurets', as they were then called, contained much of the silver of the low-grade ore. The milling process was fully described by John C. F. Randolph, who originally reported on the Batopilas properties, in Vol. X of the Transactions of the American Institute of Mining Engineers. It was upon Randolph's advice that Shepherd and his friends bought these Batopilas mines from a Mr. Robinson who had worked them in Mexican fashion on a small scale for years, and who was then about 70 years of age. It is interesting to note that Robinson moved to Chihuahua and there became interested in opening up the old Santa Eulalia silver-lead mines, which have since become so productive.

How was the silver extracted?

The native silver was extracted by pan amalgamation, and the concentrate was treated by the hyposulphite leaching process, after roasting. That was the process in vogue all over the West at that time for base silver ores. Walter Brodie was the mining engineer in charge, and he is still consulting engineer for the property, with headquarters in New York.

How long were you there?

Three years, until 1884.

You had a useful experience there?

It was particularly useful, as it was my first actual mining experience, and being given charge of subsidiary properties, sometimes at a distance from headquarters, it gave me a sense of responsibility and taught me to rely upon my own resources.

Why did you leave?

In order to get wider experience, as the mining at Batopilas was limited entirely to native silver ore of erratic occurrence and requiring but simple treatment.

What was your next appointment?

Chemist to the silver-lead smelter at Lake Valley, New Mexico; but as this plant remained in operation only a few

months, I soon returned to New York and took an engagement as mining engineer with the New York & Honduras Rosario Mining Co., in Honduras, where I remained from 1884 to 1887.

This mine is still in operation, is it not?

Yes, and only last year I received a card from the directors commemorating the company's 35th anniversary and its 197th dividend.

This was an interesting enterprise?

Very much so. It was then in the early stages of development; in fact, it was producing only 10 to 12 tons per day when I went there, and inside of two years the output was increased to 100 tons per day of gold-silver ore, an oxidized quartzose ore with occasional cerrusite, pyromorphite, and some blende and galena. On the deeper levels the lode passed out of eruptive rock into the sedimentaries and this was accompanied by a change to sulphides, and a lower grade of ore. The development of later years has discovered and opened up a whole series of profitable veins.

What was the metallurgy?

The ore was crushed by stamps and then amalgamated in pans—the original 'Comstock' pan. These, of course, have been superseded now, and most successfully, by the cyanide process.

What was the chief feature of your work at the Rosario mine?

Changing the method of working the mine from a gopher-hole of the Mexican *patio y patilla* type to the systematic operations of scientific mining and the transportation of the ore by means of a steep gravity plane and 1¼ miles of Halliday tramway, instead of by mules.

Did the climate affect you unpleasantly?

The climate, unfortunately, was malarial; the altitude at the mill was 3600 ft. above sea-level and the mine nearly 2000 ft. higher, but the foreigners suffered from malaria, and I among them. Indeed, I still have occasional unhappy reminders of my sojourn in Honduras.

So you were not sorry to have a change?

On my return to New York, I found that my friend Walter McDermott had become interested in a mine in Colorado, which experience he has dwelt upon at some length in his paper on 'Salting of Mines', read at one of the meetings of the Institution of Mining and Metallurgy in London. The ore was supposed to carry native silver in highly payable quantity, but his samples had been salted after his examination, although so careful was he of these samples and so well did he guard them, that it was only through the subornation of an employee of the express company that they were able to get at them. He and his friends had brought suit against the vendors of the mine and he wanted someone to run the 10-stamp mill he had erected on the property, to give definite proof by actual milling operations that the ore was too low-grade to pay; so I operated the mine and mill some six to eight weeks, obtaining sufficient data to sustain fully his contention.

And then?

Soon after that I was offered the management of the Darien Gold Mining Company, an Anglo-French concern with headquarters at Manchester, and in the fall of 1888, I left New York to take charge of operations at the mine, which was situated on the Darien peninsula about 150 miles south-east of Panama and about 100 miles inland on a plateau about 2000 ft. above sea-level. A description of the property was published in Vol. XXIX, Trans. A. I. M. E., by a later manager, Ernest R. Woakes. My work was that of the pioneer, having first to build a saw-mill driven by water-power, fell trees, and saw out the lumber with which to build a 10-stamp mill, meanwhile developing the mines and installing the water-power plant to run the mill. The surface-work of the Spaniards had taken the form largely of sluicing the decomposed outcrop, or *manta*, and the detritus on the hillsides, which latter were contoured with the ruins of numberless ditches. Our work was to sink shafts and open up the deposit systematically. The climate was so bad for me that I was unable to remain there long enough to fully develop all the properties. I was succeeded by William H. Radford, and he in turn was followed by

Mr. Woakes, who opened up the Espiritu Santo, or south mine. with good results.

You must have been glad to get away.

Yes, the climate was extremely trying, on account of the excessive rainfall in the wet season. By the way, while in charge of this property, I had occasion to go to England to meet the directors, among whom were Lord Charles Beresford and Mr. Hammersley Heenan of Manchester, who was then working very hard to get a bill through Parliament for the construction of the Channel Tunnel between England and France. Jacob Higson was another well-known Manchester man on the board of directors. After a rest of six months at home I took the management of the Standard Consolidated mine at Bodie, California, subsequently becoming president of the company.

This time you went to a high altitude?

About 8000 ft. above sea-level; with a climate described as "nine months winter and three months late in the fall".

What were the chief features of your work at Bodie?

The work there was extremely interesting. The credit for the resuscitation of the old Standard mine is due to Arthur Macy, a graduate of the Columbia School of Mines well known for his record at the famous Silver King mine in Arizona and elsewhere. He first examined the mine in 1890 and on his return to New York was asked to take charge of the property, which he would not do until the company consented to give him $50,000 working capital, as the property had been allowed to run down. Macy expended this money chiefly in underground development and had just got the mine into workable shape when he died, so that the most I did was to continue his work. The deposit was a system of what an old-fashioned miner would call 'gash-veins', a network of quartz veins of which many showed no outcrop, while not one in fifty went below the 500-ft. level, but which often were wide, and sometimes rich, at about the 300-ft. level.

Is that the water-level?

No, the water-level was about 800 ft. down the main shaft,

which was sunk to 1200 ft., but has not been unwatered for 25 years or more.

How far did oxidation extend?

Down to the lowest level open to inspection, that is, the 750-ft. There were not many at this level; indeed, very few of them continued below 500 ft. About four years ago I was asked to go to Bodie, to look into the question of unwatering and re-opening the mines in depth, but I was forced to advise against doing so.

You must have made at Bodie one of the early applications of the cyanide process in California?

Yes, and I found the work extremely interesting. The gulch was full of old tailing, assaying \$5 to \$6 in gold, so one of the first things done was to send a large sample (a ton or two) to the Cyanide Extraction Co. at Denver, the American representatives of the MacArthur-Forrest people of Glasgow.

What year was that?

In 1892. These people advised that the extraction was poor, so the matter of treating the tailing lay dormant for fully a year, until on a trip to San Francisco I met Alexis Janin, who told me of some successful laboratory work he was doing in cyanidation with the assistance of Charles W. Merrill, then recently graduated from the University of California. I immediately sent them some samples of our tailing, and they reported a most hopeful extraction, between 80 and 90%, whereupon I requested Mr. Merrill to come to Bodie, as I felt the necessity of testing upon a larger scale. We used two small tanks, with a capacity of half a ton each, and a small zinc-box about 6 inches square by 8 or 10 ft. long, and we ran 16 charges or 8 tons in all taken from all parts of the tailing-pond, obtaining therefrom a bar of bullion weighing nearly 7 oz., quite large enough to determine definitely whether the laboratory tests would be sustained in practice. The results were so good that we erected the first 100-ton capacity cyanide plant on the Pacific Coast, work being started in June 1894, the plant completed in September, and paid for out of the proceeds by early December, when it was

forced to close-down, on account of the severity of the weather. An interesting feature of the little plant was that the tanks were discharged by hydraulicking, using mine-water from a reservoir a few yards up the hill, the discharge-sluice under the tanks being placed at about 4% grade.

Do you recall any other interesting feature?

Electric transmission of power. We were under the unfortunate necessity of using wood for fuel at both mine and mill, at a price of $10 per cord. This made very large fuel-bills, and in casting about for a remedy, I found that L. L. Nunn, at Telluride, Colorado, had, in 1892-'93, put in a power transmission about three miles long using the Westinghouse single-phase synchronous system to operate a small mill. Finding water-power 13 miles distant from Bodie, we concluded that if power could be carried three miles it would be fairly safe to try it for 13. On consulting the General Electric Co.'s representatives at San Francisco, I found that the development of power-transmission by electricity was in such an early stage that they were still wedded to the direct current, and little as I knew about electricity, I felt the uncertainty of the methods they proposed. I then consulted W. F. C. Hasson, electrical engineer, graduate of Annapolis, who had just opened an office in San Francisco—in fact, I had the honor of being his first client. This resulted in tying up with the Westinghouse company, which took the contract to carry the power for that distance—13 miles—using a 250-kw. generator at the water-power end, direct-connected with Pelton water-wheels under 300-ft. head, without transformers, the current being generated at 3000 volts and carried on No. 1 bare copper wire to Bodie, where it was applied to the operation of the mill. The plant was in operation in the summer of 1894, but was not accepted until late in that year, on account of difficulties in protecting both the generator and the motor, more particularly the latter, from lightning and from static electricity, with which the air at that altitude was often highly charged. The first lightning-arrester was of the Wurz spool type, then just introduced, but it had to be supplemented with other arresters, and as the company was obliged to give us a 30-days continuous run before acceptance of the plant, I remember it was some months before this

was accomplished, although we were really in successful operation of the mill by electric power, and the steam-engine and boilers had been disconnected most all of the summer of 1894.

Have you any further metallurgical reminiscence?

Another interesting experience was in connection with the treatment of the concentrate from the 20-stamp mill, which I found equipped with Frue vanners and the Boss continuous pan process, which latter proved ineffective. For the treatment of this concentrate, a drying-furnace had been built of the reverberatory type, and a magnetic separator installed with the object, as was said, of taking out the excess of iron oxide. These, however, had not been used much and there was therefore a large accumulation of concentrate, which had not been shipped on account of the heavy freight and smelter charges, Bodie being 40 miles from the railroad. We tried at once to treat this concentrate, using ton-charges in one of the Comstock pans, with a very heavy addition of salt and sulphate of copper, knowing that a base bullion would result, but there was nothing in the concentrate itself to interfere with the well-known reactions of the *patio* process. The result was most satisfactory, giving quite 85% extraction on a concentrate running from $120 to $160 per ton, so that we had a handsome clean-up. The tailing, of course, was all saved and subsequently treated by cyanidation.

How long were you at Bodie?

Four years. I went from there to Johannesburg, South Africa, by way of London, having been retained by the firm of S. Neumann & Co., as their consulting engineer. This was in 1895.

This firm controls several mines on the Rand, I believe?

At that time, while they had large interests, they had not the control and operation of many mines, but this situation changed in a short time, so that they became responsible for the operation of such properties as the Consolidated Main Reef, Wolhuter, Witwatersrand Deep, Knight Central, Vogelstruis Deep, Treasury, and Cloverfield Deep.

What seems to you now to have been the chief feature of work on the Rand, as you saw it?

change of ideas among the engineers and metallurgists that had to solve them was cordial and unrestricted.

What did you think of British company methods?

The English methods of company administration, with their reports conspicuous for their thoroughness and their close attention to detail, were something of a lesson to the American mining engineer. The American, always keen for results, was in those days given perhaps to taking too many short-cuts with a possible slurring of apparently unimportant administrative details. The influence of the thorough and methodical methods of the English administration was most salutary. The explicitness of the reports of the Johannesburg mining companies is a case in point. Take for illustration a report just received from one of my old companies for the quarter ending July 31, 1916. Although it has been operating for over 20 years it starts with a statement of its capital thus:

"Capital - - - - - - - £860,000
"In 860,000 fully paid-up shares of £1 each. (Fully issued.)"
Then the directorate with the names of directors and alternates.
"Head Office - - Cullinan Building, Johannesburg."
"London Office - Salisbury House, London Wall."

Then follows, "Expenditure and Revenue statement" (for the quarter).

"Calculated on the basis of the tonnage milled."
"120 stamps, 4 tube-mills, and cyanide works.
"Milled, 107,000 tons."

Detailed "Working Expenditures and Revenue" given in two columns one of the totals and one of "per ton milled," and final totals of yield, cost, and profit for the three months as follows:

		Per ton.
Cost	£95,161	17s.9.45d.
Profit for quarter	40,774	7s.7.45d.
Yield	£135,935	25s.4.90d.

Then follow details regarding the operations for the quarter in mine and mill, with statement of ore-reserves, their estimated value, and so forth.

Could anything be clearer or more satisfactory to the stockholder? Most of, if not all of, even our best-managed mining companies producing gold, copper, or other metal—companies the excellence of whose management is beyond criticism—while giving in their quarterly reports to stockholders a comprehensive

war. Our families went to the Coast—to Durban or to Capetown—three or four times on various war scares and, of course, the final exodus just before the war was disagreeable on account of the crowded condition of the trains. On the whole, it was remarkable how slightly the operation of the mines was interfered with, up to the actual outbreak of hostilities.

By the way, when were you married?

I was married in March 1891, to Miss Fanny Marshall Borrowe, and we have three sons, the eldest about to be graduated with degree of M. D. from the College of Physicians and Surgeons in New York.

Do you consider that the Rand offers a good training in mining?

It undoubtedly does. It affords excellent training in modern methods of underground work, and of large-scale operations in deep hoisting, pumping, ventilation, etc., at the same time instructing in details with characteristic English thoroughness. Also for learning the particular phase of metallurgy in use there—stamp-milling and cyaniding of quartzose gold-ores—I know of no better field, but, in order to widen the young engineer's experience and knowledge, work there should be followed by work in different types of deposits in other parts of the world.

How does the Kaffir labor compare with the Mexican?

Very favorably. The Kaffir, after a month or two of breaking-in, becomes a fairly good worker. But in order to obtain the best efficiency it is necessary to employ the task system, under supervision, of which the Kaffir requires but little more than the Mexican. Like the Mexican he is docile; and as he is given no chance to drink while in the compounds, he is always ready for work on Monday morning, whereas the Mexican has his too frequent *fiestas*.

How about the white labor on the Rand?

In my time the white laborer was highly paid, sometimes to excess, considering the amount of work done. It was necessary, in order to be sure of a full day's work, to put him on contract. This was at a high figure, partly on account of the great demand,

so that a good miner would often make as much as $300 to $400 per month. All this has been remedied in the past ten years, so I am given to understand.

How long were you in South Africa, Mr. Leggett?

Eight years.

Did you go to Rhodesia?

Yes, I made one trip to Rhodesia, and saw there some of the principal mines, the Globe and Phoenix, Giant, Selukwe, and others, but I left with the impression that the country was plastered six feet deep with mining shares. The Blue Book, issued at that time by the Chartered Company, showed, if I remember rightly, some 250 to 260 companies with capitalizations ranging from £50,000 into the millions, and you could count on the fingers of one hand the number of producing paying mines. Doubtless by now this too has been largely remedied.

What was your next move?

In the autumn of 1903 I returned to London, where I opened an office in Salisbury House for independent mining engineering work, retaining connection with the firm of S. Neumann & Co. I lived at Chiselhurst, with headquarters in London, until 1907, making several trips to the United States in that time, and a couple to Russia and Siberia, including the examination of the Spassky copper mine, which was then in the early stage of its development.

Another interesting examination was that of the Sudbury nickel-copper district in Ontario, with special reference to the Victoria mines of Dr. Ludwig Mond, whose properties were at that time—1901—largely undeveloped, though fairly extensive diamond-drilling had been done. I remember suggesting to Dr. Mond, whose private car was on a side-track at the mine during the examination, that he approach the Canadian Copper Company with a view to buying them out, thereby making a business of sufficient size to be worth his while and at the same time securing going properties. That company was then diamond-drilling its extensive Creighton deposit. Dr. Mond went to Cleveland, Ohio, the headquarters of the Canadian Copper Company, but returned shortly saying they asked the unwarranted sum of

$6,000,000 and that anyway they would have to come to him sooner or later, as he controlled the only process for separating nickel and copper. Dr. Mond, in addition to his other famous work in the field of chemistry, discovered and finally put into successful operation a process for making this separation, hence his desire to secure nickel mines and his participation in mining. All the matte from the Victoria mine, after being brought up to about 40% each of copper and nickel, was sent to his works at Clydach, in Wales, for final treatment and separation. But in this case the chemist got the better of the business man, for inside of eighteen months Schwab bought these properties, which are now consolidated into the International Nickel Corporation. The Mond company, however, is also in successful operation at Sudbury.

Have you any opinion as to the prospects for American enterprise in Siberia?

I think it has been largely forestalled by the activity and initiative of the English mining houses, which have had their representatives there for the past ten years. It is true that some of these representatives have been American engineers, but they have mostly been connected with and working for London houses. I think, too, that this is too far afield for American capital, just as South Africa has always been considered to be too distant, quite aside from the fact that in the latter country all the opportunities were already pre-empted.

Then you realize, or you believe, that the American capitalist has not yet learned to use his money far from home?

I would hardly go so far as to make such a statement, in view of the amount of American capital that has been invested in mining on this continent, stretching from Alaska in the north to Chile in the south; I would rather say that American capital in the mining field certainly has been largely restricted to this continent, and apparently with good reason, considering the undeveloped areas that have existed and still exist.

When did you leave London?

In 1907, when I moved to New York, and opened an office in Broad Street, being joined there in 1908 by my friend and

former assistant in South Africa, Fred Hellmann. We remained in partnership until the spring of 1912, when I became consulting engineer for the American Smelting & Refining Company and a little later Mr. Hellmann took charge of the Chuquicamata mine for the Chile Copper Company.

Reviewing your career, what advice would you like to give to the younger men?

I think one of the most important things for the young mining engineer to bear in mind, one of the best lines of action he can adopt, is to disregard the amount of pay received during the first years after graduation and devote himself to acquiring a wide experience covering as many different types of ore deposits and methods of mining and metallurgy as possible. While thus broadening his experience he will also be enabled to make a wiser decision as to the line of work along which he prefers to specialize. I am also a believer in a young engineer spending a goodly number of years in the actual operation and management of properties, for nothing can replace the executive experience and knowledge of men so gained. If he follows this course, the matter of emolument will soon regulate itself to his satisfaction.

Are any of your sons to become mining engineers?

My eldest son receives his degree of M. D. next month. My second son, now Second Captain of the Battalion and in his last year at the Virginia Military Institute, is thinking strongly of electrical engineering as his life work, while my youngest son is only 14, and we don't know yet what he will be, but there is always a possibility of his wanting to become a mining engineer.

Do you consider that smelter settlements should be based on the price of metals, as quoted in a trade paper? Do you think it advisable and practicable to take the prices at which the smelting company actually sells the metal, and use that as a basis of settlement, making a temporary adjustment until that price is ascertained?

I think it most advisable that settlements between smelters and their customers should be based on the actual price obtained for the metal sold by the former and not upon a trade-paper quotation, but I question whether it is practicable to do this.

"It is a condition and not a theory that confronts us", and as the metals are sold chiefly by agents or selling companies acting on behalf of the smelters I doubt very much whether it would be possible to get them to disclose in each instance the actual price obtained, especially because they frequently have to carry over the metals for an appreciable length of time.

THE CONSULTING ENGINEER

*Mining has need of service from many kinds of men. Among them the consulting engineer takes a place peculiarly responsible, and calling for the most intense application not only of scientific acumen, but of character. In modern days, when mining enterprise involves the spending of princely sums of money and the direction of whole armies of men, it is to be expected that the technical adviser to the management shall be specially endowed with mental and moral vigor. That will have been made manifest in the several interviews that we have published with men belonging to this branch of the profession. There was a time when the manager of the mine and the company's consulting engineer acted toward each other as did the typical bishop and the dean, each jealous of the other's prerogatives and each keen to detect any trespass on his authority. All that is changed; the childish frictions are absorbed in the sense of big work and the need for hearty co-operation. It has been discovered, however, that the essentially critical pose of the consultant must have for its background some measure of previous experience in managing mines. The consulting engineer must graduate from mine management, not from the class-room or from the stope. In reviewing the careers of our leading consulting engineers, we find that they have served this necessary apprenticeship. For instance, in the interview with Mr. Thomas H. Leggett, appearing on another page, it will be noted that he underwent this essential preparation, after a good training at the Columbia School of Mines. He acknowledges the benefit of the grounding in mathematics that he owed to Van Amringe and in doing so he confirms our idea, expressed on another occasion, that the success

*Editorial in 'Mining and Scientific Press' of March 17, 1917.

his part in the development of the greatest goldfield as yet uncovered by the miner's pick. He places emphasis on the give and take, the exchange of ideas, and the professional solidarity of the American and British engineers then directing the rapidly growing operations of the Rand. He does not say much about the difference of opinion arising from the Jameson Raid and the Boer War, but we happen to know that Mr. Leggett took the unpopular side, because as a democrat his sympathies were with the Boers in their struggle against big odds. He may have underestimated the force of events, the political necessities that had to be faced, and the inevitableness of the conflict of ideas in his sympathy for a small people that strove to maintain independence and the right to live in their own way. He stood manfully for his ideal, and for that he was respected by those who disagreed with his inferences. Such courage to think for himself is characteristic, and in the end it evoked more respect than antagonism. In him loyalty to ideals went with the other loyalties—to his employer, to his friends, to his home. He has never been afraid to speak out, and he has always been willing to give advice or assistance to any man that asked it of him. His helpfulness to others will be recalled by many who will read these words. The remarks on Rhodesia tell an unpalatable truth. The larger part of Rhodesian mining was always done in London: the dealings in paper have been given a greater importance than the digging of ore, and for that reason Rhodesia stands today as one of the most striking examples of over-capitalization, shady promotion, and unscrupulous finance. Mr. Leggett does not say all this, but he shows his dislike of the queer doings that the Boers call *vernukerij*. Near the end of the interview he gives a bit of useful advice to the younger engineers: not to think so much of an increase of salary as to strive to obtain an increase in experience. After all, the one kind of capital that is indestructible—as long as life lasts, and longer if it goes into print—is a knowledge of men and things. At the beginning of a career it is well for the young man to see and learn as much as he possibly can in order to equip himself for the larger opportunity that comes later, often unexpectedly. Mr. Leggett's modest replies to our catechism show how great is the variety of experience that goes to the making of a thorough equipment for consulting work. We venture to

add that his record illustrates the fact that it is well to avoid, if possible, going to malarial regions. A young man does foolishly in selling his birthright, good health, for a mess of pottage—increased pay. Nothing can compensate for the joyousness of perfect health. We say that because Mr. Leggett's many friends know that much of his most effective work was done when under the handicap of malarial depression. That he overcame it sufficiently to accomplish so much is a tribute to his strong character and to a courage not simply physical. One who knew him at the Rosario mine tells how he 'caught up' some dangerous ground with the help of natives where experienced miners from Colorado had been afraid to venture. With such personal courage goes the power to lead men and to hold then in loyal service. We know that those who have worked under this engineer regard him with an affectionate respect of which he may never have been aware, until now. Does he remember the burly mine-foreman that he ordered out of his office on account of a failure to show ordinary courtesy, and how the man slunk away cowed by an outburst of righteous anger? Such courage was moral rather than physical. It is the quality that an engineer needs to preserve his intellectual honesty and to give unbiased judgment. That quality Mr. Leggett has exhibited in his appraisal of mines. He realized long ago that mining is a business, and the object of examining a mine is not to determine the genesis of the ore deposit nor to fuss over the extraction of the last 3% of the metallic contents of an ore although he knows full well the proper importance of such correlated matters—but to ascertain whether the mine will be a source of profit to those who exploit it. Of this ultimate purpose of mining he never loses sight. He is able to discard the immaterial and to arrive at the conclusion whether a mine is or is not worth the money asked for it, that is, whether having purchased it at that price, it will yield a sufficient profit in a sufficiently short time. These may be truisms, but they have become so much in consequence of the opinions expressed and the work done by such men as the subject of this sketch. In him Columbia finds another distinguished exponent of her fine traditions and the profession an exemplar of the code that guides the scholar and the gentleman.

WILLIAM J. LORING

AN INTERVIEW

Mr. Loring, you are a native of California, are you not?

Yes; I was born near Half Moon bay, in San Mateo county, California, on March 6, 1869.

Was your father a mining man?

No; my father was a lawyer, and came from Illinois. On his side my people were French and English, and on my mother's side they were Dutch and Scotch.

What schooling did you have?

A common-school education in Amador county.

Then your father moved to Amador county?

Yes; the family moved to Amador county in 1879.

You were brought up amid the sound of stamp-mills?

Yes; there were a number of stamp-mills in operation at Amador City, where we lived, at that time.

Have you any early recollections?

I recall James F. Parks, Sr., who was underground foreman of the Keystone mine; and I also remember distinctly when he left the Keystone and took charge of the Kennedy mine. As a boy, his long legs impressed me, and I often wondered whether I would ever occupy as exalted a position as Mr. Parks. My family remained in Amador City for about three years. At that time the Original Amador operated a 40-stamp mill, and I remember when it was closed down. The Bunker Hill was also operating a 40-stamp mill on Rancheria creek. As a boy I was impressed by the activity around these mines, and particularly the noise of the hoisting-plants. When I was about 12 years of age a man named Collins, who was then employed as a miner in the Keystone mine, owned a claim called the East Keystone,

which happened to be close to my home; his assessment work consisted of driving a cross-cut into the side of a hill. It was here that I began my mining career, turning a drill and doing such work as a boy of twelve could perform when not at school.

You found that more interesting than books?

Mainly for the reason that I was paid at the rate of 50 cents per day to begin with, then 75 cents per day, and my pay-day was every second day.

When did you leave school and begin your career?

From Amador City my family moved to Plymouth, in the same county, and when not at school I was employed intermittently breaking ore with a hammer and shoveling it into the feeders in the old Empire mill. There was only one rock-breaker—at the South shaft—but this was usually out of order.

When did you begin regular work?

At the age of 14, at Plymouth. My first responsible job was taking care of 16 Tulloch feeders in the old Empire mill, belonging to a property which is now part of the Plymouth Consolidated. From the feeders I was gradually promoted to be assistant-amalgamator and concentrator-man, until the mine took fire on January 26, 1888, when the property was closed down by the owners. These were Alvinza Hayward, Walter Hobart, Sr., and their Eastern associates.

What did you do next?

John E. Reaves, who was foreman of the Empire mill, took a fancy to me as a boy, and when operations ceased at Plymouth, he was transferred to the Utica mill, at Angels Camp, then under option to Alvinza Hayward and the elder Walter Hobart. Within a month after his arrival at Angels Camp he secured for me a job in a 10-stamp mill owned by George Tryon, Walter Tryon, Thomas Hardy, and James McCreight, at Albany Flat in Calaveras county. I was then 19 years of age. The Tryon mine, as it was then known, was producing very rich ore—so rich that it was possible to pound out $200 to $500 per day in a hand-mortar. The ore that was stamped yielded from $30 to $60 per ton.

So you must have got credit for being a good millman?

Evidently I was considered a good millman because when I first went to work I was put on the day-shift and remained so for one week, when I changed to the night-shift; but Walter Tryon, the superintendent, thought so well of the improvements I had made that he only allowed me to work by night for three shifts, putting me back on the day-shift, where I remained until the property was purchased by the Utica Mining Co. in the summer of the same year, namely, 1888. The mill was operated by a 52-ft. overshot-wheel, and, as is usually the case, water became short in the summer and the mill closed down until the winter rains. I was transferred to the Utica mill, then containing 20 stamps and under the superintendency of Charles D. Lane. Soon afterward the company decided to add 40 more stamps. During the reconstruction of the original 20-stamp mill and the addition of the new 40 stamps I was employed in placing machinery and doing whatever was necessary to assist in the erection of the plant. I remember distinctly having personally set the first tappets and also pounded on the first shoes that were used in the new mill at the Utica. I did that with my own hands.

How long did you remain at the Utica?

Until August 4, 1901. During the 13 years I rose to the position of assistant-superintendent of the Utica under various superintendents, including Charles D. Lane, his son Thomas T. Lane, E. L. Montgomery (formerly superintendent of the Plymouth Consolidated), Theo. Allen, and L. W. Shinn. I occupied the position of head amalgamator until April 30, 1894, when John E. Reaves was taken sick and died. I was then promoted to the position of mill-superintendent, in charge of 160 stamps, during which time the bonanza orebody in the Utica mine was discovered and worked, producing $203,000 in one month.

What made you leave the Utica?

W. C. Ralston, with whom I had become acquainted, offered me the position of superintendent of the Melones mine at Robinson's Ferry, as it was then called. He offered me a considerable increase in salary, which I accepted, taking up my new duties in August 1901. It had been decided, prior to my acceptance of the

throughout the whole scheme of operations. I had the Californian's dislike of hanging up stamps, and I also believed that the mine was capable of producing sufficient ore to maintain the mill at full capacity.

What was the result of your recommendations?

I took charge of the mine on April 11, 1902, and on that day the mine payroll had 814 men on it. The mill was treating 8000 tons monthly, and the working cost was 35s. 6d. per ton; the output barely covered the cost of operating and development, being in the neighborhood of 50s. per ton. The mine had an ore-reserve of 60,000 tons when I took charge, and at the end of the year the reserve had been increased to 120,000 tons; a bank overdraft of £10,000 and an outstanding debt of £10,000 had been liquidated; in addition £46,750 had been remitted to London. The number of men on the payroll had been reduced to 420 and the working cost reduced to 21s., the over-all cost becoming 35s. per ton.

How long did you remain at the Sons of Gwalia?

For about two years. On January 15, 1903, W. R. Feldtmann resigned as general manager for Bewick, Moreing & Co. in Western Australia, and Mr. Prichard and myself were appointed joint general managers in his place. The firm was then operating 16 mines in Western Australia, half of them in and about Kalgoorlie and the rest scattered. Among the latter was the Sons of Gwalia, and it was these scattered mines that I took charge of; while Mr. Prichard attended to the Kalgoorlie group.

So you had to travel over the desert?

Yes; I traveled about 30,000 miles a year among the various mines that were in my division. Some of the traveling was done under great discomfort, owing to the heat and dust. We did not use the motor-car until 1906. It required 64 horses to transport me on one of my round trips.

How long did the joint general-managership last?

It lasted 16 months. Mr. Prichard then resigned, and I was left in full charge in Western Australia until 1906, when I was appointed general manager of the whole of Bewick, Moreing & Co.'s interests in Australasia. This included mines in Victoria,

Queensland, New South Wales, Western Australia, and New Zealand. My headquarters were then at Melbourne.

When did you become a partner?

I acquired Mr. Hoover's interest in July 1908, when Mr. Hoover left the firm; and soon afterward I took up my residence in London, so as to be with my senior partner, C. Algernon Moreing.

When did you go to Burma?

I arrived in Burma in that year, 1908. The purpose of my visit to Burma was to look over the properties of the Burma Mines, Ltd., which owned the Bawdwin silver, lead, and zinc mines. The Burma Mines company was organized to treat 110,000 tons of slag lying in the jungle, but the intention was not to re-open the mines, at first. It was necessary to build a railway 52 miles from the Government railway in order to transport the slag to the smelter at Mandalay. This smelter was operated for two years, during which time I made yearly visits to the property, each time becoming more impressed with the possibility of opening up an enormously rich lead and silver mine below the old Chinese workings. The history of this mine had been traced back to 1320, and during my several visits I found remnants of high-grade silver-lead ore mixed up with the slag; and judging by the enormous excavation in the mountain it appeared to me that large bodies of ore must have been extracted at an unknown period. After smelting operations had commenced, we started development work on a small scale, and almost immediately high-grade ore was encountered in the form of pillars and remnants of the old workings. This was in 1910. After operating the smelter at Mandalay at excessive cost, due to over 200 miles of rail haulage, it was decided to move the smelter to Namtu, 12 miles by rail from the mine and 2500 ft. lower than the old excavations. I recall my connection with this enterprise now with keen pleasure, seeing that it has become one of the great mines of the world; and, curiously enough, the later developments and expansion have been done largely under the direction of my former chief, H. C. Hoover.

Where did you go next?

On my return to London from Burma, late in 1908, I paid

a visit to the Gold Coast of West Africa, visiting most of the principal gold mines in that country.

And you escaped malaria?

No; I did not. I suffered from malaria for two years after my return from the Gold Coast, and I do not believe that I have ever fully recovered from the effects of it.

I hope that the next mine you inspected was in a more healthful climate?

It was. It is said that I have the distinction of being the first engineer to visit the Porcupine goldfield in the early days of its boom—in January 1910. I went to this district, which is in Ontario, to examine a mining claim that had been taken under option in my senior partner's name by Henry Van Cutsem, who accompanied me on my journey to Porcupine. I went from Toronto to North Bay, and from there to mile-post 222, now called Kelsey, arriving there at 11 o'clock at night with the thermometer below zero. We were dumped into the snow with a train-load of prospectors, food, and mining implements of all sorts. My party consisted of the brothers Henry and Noah Timmins, their two partners, and A. T. Budd and Henry Van Cutsem. The recent death of Van Cutsem I regret greatly. He was a delightful companion on that trip and I shall never forget his many kindnesses to me. We arrived at the Hollinger mine, after 15 hours of sledding over a rough snow-road, at nine o'clock at night. Our road passed across Porcupine lake, which was frozen two to three feet thick. We arrived there at about 8 p. m.; the night was cold and clear, the temperature ranging around 40° below zero. When we were halfway across the lake the horses refused to go forward, and upon looking ahead much to our amazement we saw wolves about a quarter of a mile away. We had only one gun in the party, this being a 32-calibre revolver. The Timmins brothers, who knew all about wolves, would not let us shoot at them. After a consultation, it was decided to divide the party, one section to make a detour around the wolves, hoping by some means to frighten them away and thus leave a free passage for the team and sleigh. Upon making the detour we closed in upon the wolves and the nearer we approached the less did they appear to move. Upon closer investigation we found that what

we had taken for wolves was a broken-down sleigh loaded with goods, which had been scattered about the snow, and which appeared to move about in the star-lit and snow-clad whiteness of this northern night. The following day an examination, such as was possible, was made of the Hollinger and surrounding claims, then covered with snow and ice. The outcrop could be traced; in many places it stood as high as seven or eight feet above the surface. I saw the first shot fired in the outcrop, which afterward became the main shaft of the Hollinger mine.

What made you see wolves?

The optical illusion. The eye sees motion when everything is perfectly still.

Have you found any difference between English and American company methods?

American companies would do well to adopt some of the methods employed by English companies. One distinctive feature is the publicity given to results obtained and to general conditions at the mine. This enables a comparison to be made, thus avoiding the possibility of the management living in a fool's paradise. Publicity also keeps the management up to date, by inviting comparisons. I am also a believer in the British custom of annual meetings of shareholders; it gives every shareholder an opportunity to hear from directors a statement as to the many points of interest. Under the American system a manager or president considers himself too busy to give much consideration to the distribution of information to shareholders, whereas under the English system this is compulsory. The system is often called, by us Americans, 'red tape'. While it is burdensome at times, at any rate it furnishes a record and there is less likelihood of serious mistakes being made.

Have you ever attended a meeting of shareholders that made any particular impression upon you?

I have attended many meetings, all of which to my mind were most useful, and some of which greatly amused me.

What particular meeting amused you?

I have one in mind that I shall never forget. This was the annual meeting of a company operating in Rhodesia. The

property consisted of a concession covering many thousands of acres, upon which were several mines. The parent company sold mines to subsidiary companies, ran mines itself, farmed and raised cattle, was interested in all the business that a company of this nature could develop. In the early days the company had a bright future; as time went on reverses came, the shares fell, and shareholders became discouraged. This resulted in much mud-slinging at the annual meetings. I was present at one of these meetings, which was called for 1 p. m., this hour being fixed for the purpose of eliminating certain shareholders who thought more of their stomachs than they did of their business. However, the meeting was well attended and was presided over by a fine-looking old Colonel. His address to the shareholders dealt with the minutest detail of operations, and consumed over two hours. During this time such shareholders as had other engagements were compelled to leave, while a few went to sleep, but the Chairman rambled on, finally coming to the end of his speech and proposing the adoption of his report and statement of accounts. He asked the shareholders if they had anything to say before the resolution was put to the meeting; on this invitation six men in the front rows were on their feet at once. Each of the six in turn criticized the directors in the plainest language for mismanagement. While each speaker was trying to see which could get the floor first and say the worst about the directors, an old gentleman—sitting next to me in the back row of the hall—who had armed himself with reports and statements of accounts for several years past, and who had become nervous during the long and tiresome speech of the Chairman, and had tried to gain the floor as each previous speaker resumed his seat, finally made up his mind to remain standing, and wait until all the others had finished vilifying the directors. The Chairman looked over the heads of the meeting and said: "Gentlemen I have heard the remarks of Mr. Blank and I can only say what he has said passed like water off a duck's back; if there are no further comments I will put the resolution to the meeting". Whereupon the old gentleman, who had been standing all this time, became quite excited, waved his hands (grasping papers) in the air like a wind-mill and said in a loud tone of voice: "Hold on—hold on—what do you suppose I have been standing here

for, for the past hour, I want you to know, Sir, what I think of you and your co-directors"—and he certainly did tell them what his opinion was, which would not look well in print.

Where it is possible for shareholders to meet directors of companies and criticize or give expression to their satisfaction for good work, there is certainly a chance for shareholders and directors to become better acquainted than under the American system, thus, I think, benefiting the company generally.

What about your experience in the Hollinger deal?

I have already stated how I went to Canada early in 1910 for the purpose of inspecting the Porcupine goldfield. I could see, after spending a few weeks at Porcupine and Toronto, that deals in mining claims were made in the most reckless fashion. Nothing less than spot cash would do. A group of mining claims was offered to me, at my room in the King Edward hotel, Toronto, for $90,000 cash; but as no reports had been made and no work had been done upon the property I naturally turned it down. That same property was sold within two hours for $140,000 cash, the deal being completed the same day. So long as a man had four stakes in the snow he could sell a claim for a tidy sum of money. The Hollinger, at the time of my visit, did not embrace the property that is now known as the Hollinger mine, but only a part of it, for the part next to Pearl lake was offered to M. J. O'Brien, who afterward gave up his option, so that the Hollinger people were able to amalgamate the O'Brien property with the Hollinger. However, feeling sure that Porcupine would turn out some good mines, I decided to return to London and advise my partner, Mr. Moreing, to form a company, with sufficient cash capital so that he could go to Canada with at least £100,000 at his disposal to be used in any way that he saw fit. This was done, the Northern Ontario Exploration Company, with a capital of £500,000, being formed. Then £100,000 was called up and Mr. Moreing proceeded to Canada as soon as the weather moderated sufficiently to allow an examination of the surface. I left for Australia and upon reaching Port Said I received a cable from our London office stating that Henry Van Cutsem, who had remained in Canada after my departure, had secured an option on the Dome mine, on behalf of my firm, under the following terms: We were to furnish sufficient cash to develop

and equip the mine, the character of the development and equipment being specified. Out of the first profits obtained we were to reimburse ourselves for all of the moneys so expended, plus interest, after which the profits were to be divided, 60% to the owners and 40% to my firm. I thought so well of the Dome property that I cabled my firm, strongly recommending that the terms be accepted, provided the property included the big outcrop from which the mine took its name, with enough ground to protect its dip and lateral extent; and I suggested that a reliable surveyor be engaged to check the lines. I proceeded on my way to Australia, expecting the deal to go through, but, much to my disappointment, when I reached Colombo a cable was awaiting me stating that owing to our heavy interest in the Maikop oilfield it had been decided not to exercise the option on the Dome property. Mr. Moreing eventually proceeded to Canada, to exercise his own judgment as to the purchase of other prospects. He was met at New York by Henry Timmins, of the Hollinger mine. By this time the Hollinger had been incorporated into a large company and Timmins's partners had also acquired a large number of other claims in the Porcupine district. It was decided between Messrs. Moreing and Timmins that a number of the Timmins holdings, outside the Hollinger, should be sold to a new company, which was to be formed by our firm, headed by Mr. Moreing. The terms and conditions of the sale need not be recited, but I may say that the Timmins people received a fairly large sum of money, together with a considerable share in the new company, which was eventually called the Ontario Porcupine Goldfields Development Co. This company was formed in London and the Northern Ontario Exploration Company took an interest in it. Mr. Moreing visited Porcupine and inspected the Hollinger mine, which had then reached a depth of 200 ft., where rich ore was being exposed. On the day of Mr. Moreing's departure from Canada, Mr. Timmins agreed to sell 50,000 Hollinger shares to the Northern Ontario Exploration Co. on the understanding that these shares should be taken to London and a market made for them there. My firm was appointed transfer-agent for the Hollinger company. The price per share, I believe, was $4. Mr. Moreing arrived in London in due time, and the developments in the Hollinger continued most satisfactorily. As is well known, a

You must be pleased with the development of the Plymouth Consolidated?

I am proud of the fact that I was personally responsible for the re-opening of the Plymouth Consolidated mine, which has up to date produced a profit, over all expenditures, of $630,-937 in a period of 36 months. As you are aware, I worked at the Plymouth as a boy and remained at the mine until it closed down, on account of fire, in January 1888. It was then operated by Alvinza Hayward, Walter Hobart, Sr., and their Eastern associates.

Mr. Loring, you are married?

I am; I was married to Miss Marie Ellen Everhart, at Angels Camp, California, on December 12, 1888. My wife has followed me in all of my wanderings.

You have a son?

Yes, my son Edward Amos Loring is a partner in our firm, and at the present time is in London attending to the engineering department of our business.

You are still an active member of Bewick, Moreing & Co., although you live in San Francisco?

I am, I am pleased to say.

Why have you changed your residence from London to San Francisco?

The change is only a temporary one, I hope. Before the beginning of the War I came over from London to see the new mill at the Plymouth Consolidated begin operations; the intention being to proceed from California to Japan, Korea, China, and back to London through Siberia. I visited the Far East, but, owing to the War, decided not to return to London through Siberia, but to return to the United States; and as my partners were willing to take care of the London business, during my absence, it was decided that I should remain in the United States for the time being, to build up a branch of our business in this country. I have been enabled to start several promising enterprises, financed by my personal Boston friends, and these will keep me here for some time.

When were you in Korea?

The latter part of 1914. I visited Korea for the express purpose of looking over the properties controlled by my friend, H. H. Collbran. He has developed a unique mining enterprise in Korea, on the Suan Concession, and is at the present time operating what is known as the Suan and Tul Mi Chung mines. Since my visit he has opened up another mine which gives promise of being a very good producer. Fortunately, his rights antedate the Japanese occupation and he is able to operate under their friendly protection.

What advice would you give to the younger men, or to their fathers, in regard to the preparation for a mining career?

My advice would be the same as I gave to my son when he was preparing to enter the university at Sydney: to select certain lines of study that in his opinion would be most useful to him and to avoid a smattering of many subjects; also, as far as possible, to mix with his university education the practical side of mining during vacations. The result has been that while my son is barely 27 years of age he has considerably more experience than many mining engineers ten years his senior. I most certainly advise young folks to gain as much education as possible, and not leave their future to the mercy of experience as a teacher. Experience is as necessary as schooling, but it is slow and uncertain. Some men have made a mark in the world without a college education, but it is becoming more difficult as time goes on to accomplish great things without a special training. An educated young man has a great start over an uneducated young man.

MAKING A CAREER

*Mining makes demand upon a great variety of talent, and the successful application of that talent is conditioned by the vicissitudes inherent in the adventurous search for mineral wealth; so that the career of the mining engineer is not without a romantic element. He may climb from a small opportunity and attain to a big achievement; he may begin in a frontier camp and end in the seats of the mighty; above all, he may

*Editorial in the 'Mining and Scientific Press' of November 3, 1917.

start under a heavy handicap and yet become a winner in the long race of life. This is true of other professions, particularly in this land of opportunity, but in mining it is linked to the great adventure—the opening of an Aladdin's cave under the crust of the earth. Several of the most notable men in our profession have achieved distinction despite the absence of those early educational advantages that they themselves have not failed to give to their own sons. We confess to sincere admiration for the force of character that can surmount an obstacle so fundamental. In this issue we publish an interview with a distinguished mining engineer in whose life natural abilities backed by tenacity of purpose have triumphed over the lack of conventional education. Mr. W. J. Loring is a native Californian whose childhood was spent amid the muffled thunder of the stamp-mills. From the first he knew that men make holes into the ground to find the golden ore, which they then smash into powder in order to separate the gold from the worthless quartz or slate with which the precious metal is enveloped. Early he realized that the purpose of mining was to make money, and early he was impressed with the essential virility of the men that directed technical operations. His reference to James Parks will be appreciated along the Mother Lode, for that worthy mine-manager was a notable figure in the foot-hill country and represented a type of man never common, who combined good judgment with ready initiative and sterling integrity. At an age when most boys have just begun their schooling Mr. Loring learned to hold a drill and to do the small work about a mine, following this with similar labor in a mill. One who has broken ore with a hammer and fed it with a shovel into a stamp-mortar will appreciate the aid of the automatic crushers and feeders of a later period. Personal experience in the benefits of mechanical development must stimulate an intelligent interest in labor-saving devices. Thus, in the years that followed, Mr. Loring helped to test and use various appliances that release human muscle for more effective service in the mine and mill. As a young man he worked with a progressive group of men. His experience in treating the contents of a pocket of specimen ore, in the Tryon mine, was useful in preventing him thereafter from becoming excited at the sight of free gold. By that time, when he was barely 20, he had attained a position of considerable re-

sponsibility and had the satisfaction of taking his part in the erection of the Utica mill, which was destined to extract several millions in gold. His chief, Charles D. Lane, was one of the last of the old type of Californian miners; from him he acquired the zest for mining adventure, the prospector's love of underground exploration. As Charlie Lane used to say: "I am digging all the time, and praying like hell". He knew that he needed the aid of luck—every miner does—and if he went too often to spiritualism instead of to science, like his associate Alvinza Hayward, yet he had that saving common-sense that is closely akin to science, and through it he was saved from many of the stupidities into which spirit-rapping might have led him. Fortunately, Mr. Loring acquired the practical sense of these old Californians without being attracted by their mystical vagaries. In due time a call came for service in a larger and more distant field. He went to Australia, on the invitation of the Hoover brothers. It is a far cry from the young engineer in that mine-manager's office in Western Australia to the Food Administration's building at Washington, but the qualities manifested by Mr. Herbert Hoover fifteen years ago are those that he is now using to such great purpose. Our readers will like Mr. Loring's reference to his former associate, through whom he obtained the great opportunity of his career. It enabled him to prove his mettle. Then, as now, he realized that the object of mining is profit, not low cost per ton or high extraction, except in so far as these are contributory to the main result. His early training made him a keen millman, but he realized that the major economies were to be made in the mine itself. He studied the cost-sheet and kept his eye on the payroll, for 60% of the total cost of mining is labor. The success scored by him at the Sons of Gwalia marked him as a capable administrator. Here we may refer to the joint management of the Australian mines under the direction of Bewick, Moreing & Co. in 1903. We refer to this simply to lay stress on the inadvisability, to put it mildly, of such division of control. The experiment has been tried so often that it is no longer an experiment but a precursor of inevitable failure. The reader will note Mr. Loring's part in starting the smelting of the ancient Chinese slag-dumps at Bawdwin, now identified with the important enterprise of the Burma Mines company. The story of his reconnaissance

at Porcupine, in its early stages of development, is likewise interesting. We ask the younger men to note again the injury done by malaria. In Mr. Loring's case it was slight, but the mention of it gives us the opportunity once more to advise young men not to sell their birthright—good health—for a mess of pottage—an increase of pay. We would like to dwell on Mr. Loring's remarks concerning the British administration of mining companies, but space will not permit. The publicity given to operations and the protection given to shareholders are admirable, but the red tape, the figure-head direction, and the scattering of responsibility are points of obvious weakness in the British system. After engaging in professional work around the world, Mr. Loring has returned not only to his native land but to the very mining region in which he made his start. By his successful re-opening of several mines on the Mother Lode he has proved that a proverb can be read backward as well as forward, for he is held in honor even in his own habitat. He has retained the qualities early ingrained, the love of mining itself; "he likes to dig", as Charlie Lane said; he is keen on milling, now supplemented by flotation; he is kind to workmen and is liked by them, so that he can get the best out of them; while climbing the ladder of professional success he has not lost the sense of comradeship and the sympathetic touch that makes the ideal employer and manager. We note his own regret that he missed the educational opportunities that he has taken care to give to his promising son, but to this day his judgment of a mining venture is better than his technical description, which exemplifies the dominance of the practical over the theoretical in his mental development. The same utilitarian sense may be acquired by men of full technical training who, in the spirit of ambitious apprenticeship, have not hesitated to learn the business details of mining after graduation from college. The point is that Mr. Loring does not belong to that class of so-called self-made man whose boast is that he has dispensed with technical training. The question arises whether such men as Philip Argall, J. H. Mackenzie, D. M. Riordan, and W. J. Loring, successful engineers whom we have interviewed and who have told us how they overcame the lack of a conventional education, would have done better if they had been better equipped at the start. The answer cannot be made confidently. The handicap spurs the

runner, the absence of equipment and patronage necessitates special effort, under which the best qualities of the man may have the best chance to grow. If similar force of character could have been developed along an easier trail, it is likely that the educational help would have been turned to good account. To a mining engineer a college training is a short cut; by aid of it he can learn more rapidly and think more logically than the man not so assisted. He fails often because his essential manhood has not been trained with the severity that marks the life of his less favored comrade, who has to depend entirely upon native intelligence, pertinacity, courage, and opportunity. It is fair to judge a man by what he has achieved. We respect the man that makes the most of his opportunities. It is more than delightful, it is inspiring, particularly to the young, to see men overcome the limitations of their environment and prove that strong character is not to be held down by the fortuities of place and environment. Possibly the consciousness of limitations is less oppressive in a mining camp, for instance, than in a great city. The man who deals daily with a great variety of persons unequally educated has a better chance of becoming conscious of mental power, and is encouraged thereby to forget his own handicap; he is encouraged to overcome that handicap and to place himself on a level with those who have undergone a special education, and to find, if he persevere, that their accidental advantage over him is less decisive than is the natural capacity with which he was born. Thus mental power and essential virility enable men to conquer circumstance and achieve their purpose, which is to be happy and effective.

ANTHONY F. LUCAS

AN INTERVIEW

Capt. Lucas, you are of European origin?

Yes, Sir, I was born in Dalmatia, Austria, in 1855. My forefathers, however, were of pure Montenegrin blood.

What was your father's occupation?

He was a ship-builder and ship-owner on the island of Lesina.

So you had an interest early in engineering. What was your education?

My family moved to Trieste, where I was educated in the high-school and after that in the Polytechnic of Gratz; at the age of twenty I was graduated as an engineer.

After graduating, what did you do?

I entered the Austrian navy as a midshipman and was promoted to second lieutenant. At that time an unpleasant incident made me very much dissatisfied with the rigor of the service, perhaps because of my Slav origin, so that I was glad to accept on invitation to pay a visit to an uncle of mine in this country. For that purpose I obtained a six months' leave of absence and came to the United States. That was in 1879, when I was 24 years old.

I have an idea that your father's name was not Lucas.

My father's name was Luchich. The reason of the change was that when I came to America on a visit to my uncle, my father's brother, as I have stated, I found that my uncle had adopted the name of Lucas, owing to the difficulty that Americans had in spelling and pronouncing Luchich. So, for the time, expecting to remain only three or four months, I permitted myself to be addressed as Lucas. When I decided to reside in the United States I retained this modification of the name.

What caused you to remain?

An engineering problem was offered to me during my stay in Michigan. At that time Michigan was a lumber country, and Saginaw, where I resided, was its centre. A gang-saw was needing some improvement in design, and when asked if I could do it I agreed with pleasure, completing the design satisfactorily to the millmen. Later on I was asked to supervise the erection of this gang-saw. Then, just as the end of my leave was approaching, I was offered a flattering engagement, which, after some consideration, I accepted, asking, however, for another six months' leave. At the end of that time I had made up my mind to become an American citizen; I made proper application and completed the change of allegiance by obtaining my final papers four years later at Norfolk, Virginia, on the 9th of May, 1885.

Did you ever return to Dalmatia?

Yes, in 1887, nearly ten years after, on my wedding journey. My wife and I went to Trieste, Fiume, and Pola, and to the place where I was born, Spalatro, which, by the way, is an old Roman city erected by the emperor Diocletian. Although I had some fear of contact with the rigor of the Austrian law, I was not troubled. On the contrary, I was entertained at Pola by the officers of the Navy and ascribe my immunity to having good friends, but perhaps it was Mrs. Lucas' charm of manner or because she was unmistakably American. I was abroad one year.

On your return from your wedding journey, where did you settle?

I made Washington my home, and entered the profession of mechanical and mining engineering. First I went to the San Juan region in Colorado and prospected for gold, with some little success, but after two years I returned and began to look around for a good opening in the mining industry, and became employed as mining engineer at a salt mine in Louisiana, in 1893, at Petit Anse, where I practised the engineering and mining of salt for three years.

What was the nature of the exploitation?

I found the salt deposit only 20 ft. below the drift-soil, and the shaft 180 ft. deep. Mine and mill were in very bad condition owing to the fact that water had found its way into the

mine and caused a large cave. The mill was antiquated. It required constant care to check the caving and water in the mine, and the ravages of the salt on the mill machinery.

Was there any other technical feature worth mentioning?

Yes, the system of mining. I opened long drifts in virgin ground, adopting an overhead method of mining, feasible only under such conditions. A gallery was started with a 7-ft. under-cut, 50 to 60 ft. wide, and from 200 to 300 ft. long. After clearing away this broken salt in tram-cars the second under-cut was started, 18 to 20 ft. in height, and when this was cleared the final mining was begun with the aid of three-pod ladders upon which light hand-drills were placed, drilling batteries of holes 10 ft. deep. Thus six or eight holes shot down hundreds of tons of salt. This method proceeded until, by the time the height reached 50 ft., no more ladders were needed, owing to the increased volume of the salt. The roof, of course, was arched toward the 40-ft. pillars left standing. Suspiciously loose slabs of salt were pried down or shot down to make the roof safe, and by the time the men had finished there remained a mass of from 3000 to 5000 tons of broken salt ready to be trammed and hoisted to the mill. By this method not a board or stick of timber was used or needed.

When the mining in this chamber was completed, another under-cut was started laterally and we thus had always in reserve one or more chambers full of broken salt, 60 ft. wide, 60 ft. high, and 200 or 300 ft. long, each containing from 3000 to 5000 tons, at a cost of less than 14 cents per ton of salt mined. The salt was of unusual purity, 98.5 to 99% sodium chloride, the remainder being gypsum.

What did you do next?

During the three years that I was employed there I became acquainted with Joseph Jefferson, the famous actor, who had an island known by his name, a few miles off Petit Anse. Mr. Jefferson was anxious to bore for water, and had actually given a contract, but the contractor found difficulty in complying with the terms of his agreement, owing to the boulders and sand through which he had to drill. At this time Mr. Jefferson asked me if I could see my way to help the contractor. Although employed by the salt people, I accepted eagerly, and

helped by introducing a method of driving the casing and succeeded in assisting the contractor to pass through the gravel bed. About 100 ft. deeper we struck what appeared to be solid rock, but upon analysis, it proved to be an enormous bed of salt. Then Mr. Jefferson asked me if I would continue the exploration in an advisory capacity, which I did. I purchased a diamond-drill from the Sullivan Machinery Co., of Chicago, and drilled to the depth of 2100 ft., still in salt, a total thickness of 1750 ft. of salt, without encountering any foreign substance.

What did you do with this discovery?

During my operations at Jefferson island rumors were spread by uncharitable persons that I was fooling Mr. Jefferson. I was asked, if I claimed I had so much salt, why did I haul carloads of salt from Petit Anse to Jefferson island. It is true I hauled several carloads of waste salt, but only to use as brine with which to bore, so that it would not enlarge the bore excessively. You will understand that if I used fresh water I would have dissolved the walls of the bore. Owing to this malicious gossip, Mr. Jefferson asked me if I had found enough salt as he wanted to stop. I replied that I had salt enough to salt the earth; I was proceeding nicely, and was anxious to find the floor of the salt, when he stopped me at 2100 ft., thus balking a possible study in geology, for I wanted to learn on which geologic formation this salt was resting.

That must be an enormous mass of salt, do you know of any larger?

The salt mines at Wielitzka, in Austrian Poland, are worked at over 3000 ft. in depth, and the potash salt mines in the Stassfurt district of Germany are worked to over 1500 ft. in depth, but the salt deposits of our Coastal Plain now surpass both of those in quantity and extent.

Probably you had an idea of mining from that floor upward?

No; because I found on subsequent borings that the salt mass was in one locality only 81 ft. from the surface, and to mine at a depth below 2100 ft. would have been costly and unnecessary when one could mine at a reasonable depth, say, 500 ft., and leave between 200 and 400 ft. of solid salt for a roof.

Mr. Jefferson, however, decided to leave this deposit to his grandchildren, and I heard only recently that it has been sold.

So, Captain, you had to make another start?

Yes; in the meantime I had examined a small island known as Belle Isle, on the Gulf coast, one of a series of five islands now well-known for their salt deposits, and contracted with the owner to explore Belle Isle for minerals on my own account. I undertook to explore the land by perforations. Four wells were drilled for salt, discovering thereby a deposit not only of salt, but of sulphur and oil as well.

How were these three deposits related to each other?

The first well was a miss; the second well penetrated a 66-ft. bed of sulphur, and below that I discovered the matrix of a salt dome. By further boring I encountered oil-sand at a depth of 115 ft., and deeper down, at about 800 ft., I discovered a strong flow of petroleum gas. Resting there, I completed my contract, and acquired title to one-half of the mineral resources of the island.

You then proceeded to exploit the oil?

I did not have the money. The island was purchased later by the American Salt Co., and I received a consideration of $30,000 in bonds and $5000 in cash. This led me to study the accumulation of oil around salt masses, and I formed additional plans for prospecting other localities. Thus I began my investigations into the occurrence of oil on the Coastal Plain. That was in 1897. I fully expected that the American Salt Co. would put me in charge of their operations, but they did not make me the offer and I did not make any request. They sent a New York salt man and began large operations, involving over two million dollars.

Which of the three minerals did they exploit?

Salt only. Unfortunately, the method of mining salt in Wyoming county, New York, was not adapted to the deposits of the Coastal Plain. They started sinking a large working shaft where it showed nearest to the surface, at 115 ft., without having previously sounded the deposit by boring to ascertain its conformation and purity. Salt is much in demand from the

meat-packers of the interior, but this particular salt was unmarketable because it was impregnated with oil and gas. In bailing out the salt-cuttings and dumping them on the floor, they would explode like pop-corn. This was caused by the sudden liberation of gas coming in contact with the air. In my exploration of the various salt deposits of the Coastal Plain this was my only experience of the kind.

What did the contractors do?

They sank to a depth of 250 ft. and started driving toward the interior of the deposit, searching for purer salt. When I heard what they were doing, I telegraphed at once asking if the drift was in the right direction, and if they had sounded with a diamond-drill in that direction. Unfortunately, the next news was that they had passed through the salt and had penetrated quicksand. The mire of the marshes drove them out and they barely had time to save the men, thus losing the first shaft. It proved afterward that the salt in this locality formed a depression, 500 ft. westward, although it was connected with the main dome. They started another shaft westward, but made a series of woeful blunders. The salt was not so shallow there and they had to go down 276 ft. before they reached it. On top of this salt they found a layer of about 30 ft. of bad quicksand through which they could not pass. They then employed an expert shaft-sinker, named Sooy-Smith, who employed a freezing process. Another unfortunate incident was that Sooy-Smith never put the brine-pipes in the salt; he stopped in this quicksand, so that when the mass was frozen, preparatory to mining, they were just as badly off and could not pass the quicksand. They spent a large sum of money, finally abandoning the effort. They then proceeded to explore for oil, and after a series of efforts gave that up. The island was sold at public auction and is now the property of the New Orleans Mining Corporation.

That did not stop your prospecting, I feel sure. What did you do?

I explored Weeks island, also in Louisiana, and there discovered a magnificent bed of salt now being worked with commercial success. Meanwhile further investigation led me to proceed. I selected a point known as Anse la Butte, six miles north of Lafayette, in Louisiana. In this locality I again discovered oil and salt, but not under favorable conditions. (Since

that time, however, it has produced and is still producing large quantities of oil.) So I abandoned the discovery and went to Beaumont, Texas, about 70 miles west of Lafayette. There I was attracted by an elevation, then known locally as Big Hill, although this hill amounted merely to a mound rising only 12 ft. above the level of the prairie.

What led you to prospect there?

This mound attracted my attention on account of its contour, which indicated possibilities for an incipient dome below, and because at the apex of it there were exudations of sulphuretted hydrogen gas. This gas suggested to me, in the light of my experience at Belle Isle, that it might prove a source of either sulphur or oil, or both. I decided to test it therefore and leased all the ground that I could secure.

How many acres?

The hillock covered only 300 acres, of which I secured 220 acres; but I leased altogether about 27,000 acres in the vicinity in order to have ample scope for exploration, although this proved unnecessary, as no oil was ever found beyond the contour of the dome.

What was your first result?

This elevation had already been explored by three companies and none succeeded in penetrating below 250 ft. in depth.

Why?

Because a bed of quicksand was struck at about 200 ft. Knowing that they used cable-drilling apparatus, I decided that that must have been the reason for their failure, so I set to work with rotary-drilling tools. The rotary drill at that time was almost unknown and was only used for artesian-water wells of shallow depth on ranches and rice plantations. I penetrated the quicksand and soon realized that I was correct in my surmise of the reason why my predecessors had failed. I managed to pass the quicksand and bored to a depth of 575 ft., encountering an oil-sand but losing the well by gas collapse. I thought best, however, before proceeding with heavier rotary-drilling machinery to seek geological and financial aid, so I went to a number of capitalists and laid before them my plans and expectations; but they turned me down. I recall one instance, when

a friend took me to see former Congressman Sibley, of Pennsylvania, to lay my project before him. He read me a lecture, and stated that he could not participate in such a wild scheme; that unless I had a production of so many thousand barrels per day to count upon, he was obliged to decline; to which I replied, that if I had such a production I probably would not have come to see him.

You did not abandon your quest?

No, I went to others, for instance to H. C. Folger, Jr., of the Standard Oil Co., in February 1899. I had a bottle of the oil with me and it happened to be a bitter cold night in New York. Having my ideas on practical issues, I put the bottle out of my window in order to give it a cold test. The oil was 17° B. gravity; it did not seem to congeal at all, although I understood that the temperature outdoors was two or three degrees below zero. Happy in this test, I went to see Mr. Folger, and laid the matter before him, asking him to join me. I told him that I did not want money personally, only assistance in further prospecting and proving the field; but Mr. Folger, while he received me graciously, declined. However, he promised to send Call Paine, of Titusville, the then Standard Oil expert, to examine my scheme. Paine arrived a month later, with J. S. Cullinan, who later became president of the Texas Company. I showed them the location of my first shallow well and the heavy oil extracted therefrom. I also explained to them my 'nascent dome' theory. It ended, however, with Mr. Paine giving me a piece of well-meant advice, to wit, that there was no indication whatever to warrant the expectation of an oilfield on the prairies of southeastern Texas, that he had been in Russia, Borneo, Sumatra, and Rumania, and on every oilfield of the United States, and that the indications I had shown him there had no analogy to any oilfield known to him, that I absolutely had no chance, as in fact there was not the slightest trace of even an oil-escape; in conclusion, he advised me to go back to my profession of mining engineering.

That was a squelcher; did it crush you?

I retorted by showing him a demijohn of the heavy 17° B. oil, obtained at 575 ft. He characterized it as of no value and of no importance whatever, stating further that such heavy

stuff could be found most anywhere. I am, however, convinced that Mr. Paine was sincere in his advice, which naturally shook my confidence.

Another incident happened during the fall of 1899 to shatter my faith in the venture. Charles W. Hayes, formerly Chief Geologist of the U. S. Geological Survey, accompanied by Edward W. Parker, formerly Chief Statistician of the Survey, dropped in on me to see what I was doing, and I explained to Mr. Hayes in detail my deductions of possible oil accumulations around great masses of salt, etc. He also discouraged me, saying that there were no precedents for expecting to find oil on the great unconsolidated sands and clays of the Coastal Plain, pointing to the well drilled by the city of Galveston, Texas, over 3000 ft. in depth (a big undertaking at that time and one that cost the city nearly a million dollars), stating further that I had no seepages of oil, as a leader or indication, etc. I pointed to the great sulphur dome near Lake Charles, at that time in course of development by Herman Frasch, whereon a limited production of 1½ barrels of oil was obtained—a heavy oil, it is true, and a straw for me to grasp—but no encouragement could I get from Mr. Hayes, whom I, of course, knew as one of the best geologists in the country. Thereupon I began to seek co-operation and financial aid from some one better fortified than myself financially. This led me to enlist the aid of J. M. Guffey, of Pittsburgh, who took my proposition up, but to whom I was obliged to relinquish the larger part of my interest in the venture. In the first well that I drilled with Mr. Guffey's money, at a cost of less than $6000, at a depth of about 1100 ft., the oil came with a rush of over 100,000 barrels per day. This was on the 10th day of January 1901. Next day I received a telegram from Mr. Paine extending to me his warmest congratulations on my success and saying that he was coming down to see the new wonder. He little knew, however, that he and Mr. Hayes were the indirect cause of my "selling my birthright for a mess of pottage". Mr. Cullinan also appeared next day and became a large factor in the Spindle Top field, realizing millions thereby, and enabling him later to organize the Texas Company, a corporation now worth its hundred millions of dollars. Mr. Guffey, with Andrew Mellon, of Pittsburgh, organized the J. M. Guffey Petroleum Co., with a capital of $15,000. This capital was later

largely increased, and later still the title of the company was changed to the Gulf Petroleum Company.

So Guffey became associated with you?

Yes, he was a noted petroleum operator in Pennsylvania. I entered into a contract with him that he should drill three wells, at least 1200 ft. deep, under my direction.

Did he undertake to supply the capital?

He undertook to stand the expense of three wells, and I was to superintend the operations. The first well, however, proved the Lucas gusher at a cost of less than $6000.

You proceeded to work?

I contracted with Al and Jim Hamill, of Corsicana, to drill three wells at $2 per foot, we to furnish the casings. I took charge of the drilling and chose a site where the now famous Spindle Top, or Lucas, gusher, was developed.

Kindly outline the events that led up to the escape of oil.

The first casing was 12 inches, reducing the diameter finally to 6 inches. When we reached the quicksand, at about 300 ft., we began to have trouble; our drill-pipes stuck. The 6-in. pipe was relieved by going over with an 8-in. pipe, which in turn became stuck, and I, knowing that the practicable limits had been reached, was in great distress to proceed with the work. I could not sleep that night, but toward morning the thought came to me that if a boiler having a 100-lb. pressure of water could be pumped full without any water coming out, there was a reason for it, and the reason was that it had a check-valve alongside. That proved on eye-opener to me. Much excited I hastened to see my driller and explain what I wanted. Thereupon I designed a check-valve, made out of the boards of a pine box lying in my back yard, and with openings in the centre and a small rubber belt underneath I placed this check-valve between the coupling of the casings, and thus proceeded without any further trouble.

Did you patent your invention?

No, at the time I had it in mind to do so but was deluged with work and incipient possibilities. If I had done so I would have realized a large amount of money.

How did your drilling proceed by aid of the check-valve?

The drill-hole proceeded through various layers of quicksand to 800 ft., then struck lime and sulphur for about 250 ft., to a few feet less than 1100, and while we were lowering the casing, after having sharpened the bit, the casing (which was attached with a block and five strands of 2-in. cable) began to rise, increasing in momentum until the whole casing of about 1100 ft. was shot out to an unknown height, carrying the heavy block and the head blocks of the derrick with it into the air, followed by a gush of muddy water, our own drilling-water, then by rocks and fossils, and finally gas. It then settled down to a magnificent 6-in. stream of solid oil of 23° B., rising to a height of 200 ft. That was the celebrated gusher, which ran wild for 10 days, making a lake of nearly 30 acres, which was impounded by levees that I built to confine it.

Were you charged with damages?

I was served notice by the railroad company and by a marine insurance company at Port Arthur and Sabine Pass that ships were endangered, as a great deal of oil had found its way to these seaports, 16 miles below on the coast, and requesting me to remove the oil. The Southern Pacific Railroad company also served notice on me to remove the oil because of the danger to the tracks, etc.

How did you control the flow of oil?

During the ten days that preceded the closing of the well, I had innumerable offers from irresponsible people to close it for me, because some newspaper had published a statement that I would give $10,000 to any one who would close the well. One of the offers was made to me by a woman in Illinois. She telegraphed that if I would put the $10,000 in a bank, subject to her order, she would use her occult power to discipline nature. However, I realized that it was up to me and my men to solve the problem. In 10 days we completed the construction of a steel-rail carriage to pass an 8-in. gate-valve over the 6-in. stream of oil. At 10 o'clock in the morning of the tenth day, with the aid of block and tackle, I started to drive and drag this valve, which was woven with the iron rails, to enter this powerful stream. At the first impact when this gate-valve, which was open, came in contact with the stream of oil, the derrick, badly

shaken but still holding, began to rock, and I remember picking up one of the fossils on the ground to throw at the horses so as to urge them to faster speed, until finally the valve passed the stream of oil, which was turned inside of it. Then we screwed the valve on the 8-in. casing, and that closed the gusher. This discovery of oil led to the development of a big oilfield, which became known as Spindle Top. It has produced over 50,000,000 bbl. of oil, and is still producing.

I hope, Captain, that you received a proper financial reward this time?

I did, but my chief reward was to have created a precedent in geology whereby the Gulf Coast of the Coastal Plain has been and is now a beehive of production and industry. Owing to the fact that Mr. Guffey and the Mellon group had a lot of money and I had not, I accepted their offer and sold my interest to them for a satisfactory sum.

Did you stay there long?

I severed my connection with the Guffey Petroleum Co. about six months after the Beaumont discovery. In selling to them I retained the leases that I had acquired at High Island, near Galveston, an entirely different locality, 70 miles south-west of Spindle Top. I also secured land and drilled a well for the Guffey Petroleum Co. on another dome, then known as Bryan Heights, on the Gulf, some 40 miles south-west of Galveston.

What success did you have?

In July 1901, at 800 ft. deep, I struck a powerful force of sulphuretted hydrogen gas, which drove my men and everybody else off the location. Unfortunately, the company neglected that discovery and it became forfeited in the next three years; subsequently it was taken up by speculators, who induced Eric L. Swenson, one of the directors of the National City Bank of New York, to proceed on the basis of positive knowledge of a sulphur bed existing there. Mr. Swenson organized the Freeport Sulphur Co. and is now exploiting it by aid of the method applied by Herman Frasch at a similiar sulphur deposit, in Louisiana, by the process of melting the sulphur with hot water and forcing it to the surface by the pressure of hot air.

This, together with the operations of the Union Sulphur Co., is one of the main sources of sulphur supply in the United States, and is proving most useful as an ingredient of explosives for warfare. Another well worth mentioning was located by me for the Guffey Petroleum Co., in 1901, on a tract of land known as the Damon Mound in Brazoria county, Texas, 30 or 40 miles from Houston.

What did you do there?

In order to obtain leases on this dome, I had to promise the owner, J. F. Herndon, that this well should be called by his name. The well, while it was not a success, for the reason that it became clogged and ruined at 1600 ft., enabled us to ascertain the existence of a bed of sulphur and oil. This dome is now producing between 5000 and 10,000 barrels per well per day.

So you severed your connection with the Guffey company?

Yes, I had no more interest in their affairs. This promising field became abandoned until about two years ago when E. F. Sims, of New York, began to prospect the dome, which is over 100 ft. high and one of the largest on the Coastal Plain. The result was to bring in gushers that are now yielding 10,000 bbl. per well. On another part of the dome there was exploited a great sulphur deposit, and deeper down an enormous mass of rock-salt to unknown depth. I got nothing out of this, except that I had bought two tracts of land at the time I was drilling, and two additional tracts of land that were presented to me by the Cave heirs of Paducah, Kentucky. These two additional tracts of land of 10 acres were presented to me with the compliments of the heirs, but, not obtaining satisfactory results, I deeded them back. These tracts of land are now worth a considerable amount of money, as they are producing large quantities of oil, but I retain the two originally purchased tracts, covering 17 acres. The land is now very valuable.

How many years did you spend in this region?

About three years. After that I became connected with Sir Wheetman Pearson, now Lord Cowdray, who, as you know, has large oil interests in southern Mexico.

Please say something about your Mexican experience.

In 1902 I went to Coatzacoalcos, now known as Puerto Mexico, where I located two oilfields, one known as the San Cristobal, and the other as Jaltipam, on the Tehuantepec railroad. The former is producing a beautiful light paraffine oil; the latter, a somewhat sluggish heavy oil; both, however, are attractive oilfields.

You were advisory engineer to Sir Wheetman?

Yes, and three years after my arrival in Mexico he made me a flattering offer to remain as managing engineer in Mexico, but, owing to other aims and interests, I declined, returning to Washington in 1905. Since then I have been practising the profession of consulting engineer. My work has taken me to various parts of the world, notably Algeria, North Africa, Russia, Rumania, Galicia, and Stassfurt, besides various oilfields in the United States.

Would you say something concerning the oil resources of the Tampico oilfield, which, I understand, today is so important a factor in supplying the Allies with fuel-oil?

In 1903, E. L. Doheny was operating in the neighborhood of Tampico, and his success induced Pearson to obtain large concessions there, but I had no part in it. I know that the production of the Tampico field is very large, and it contains large resources of petroleum, which is now supplied to ourselves and our allied fleet.

Have you been to any other Mexican oilfield?

Yes, through the instrumentality of Sir Wheetman, I went by way of Oaxaca in 1903 to the Pacific coast, where the son of President Diaz and other capitalists had been operating for oil near Port Angel in the State of Vera Cruz. There were no safe ports there and they were obliged to beach barges of supplies towed from San Francisco, from which place they unloaded the machinery and pipes. I found them laboring under great difficulties, for the reason that they were drilling in pure syenite, which, as you know, is a crystalline rock in which engineers in general would not expect to find oil, although there were some oozes of neutral oil on the surface. This field has never produced oil. I discouraged the continuation of this work, but owing to the fact that they had already invested a large amount

of money, they did not do it gracefully, and continued for another year and a half, until ultimately they had to give it up. Here I contracted dysentery, which kept me nearly a year confined to my home.

You have not been to any of the Californian oilfields?

No. The conditions there were not such as interested me, compared with the Coastal Plain in Louisiana and Texas.

By the way, Capt. Lucas, you have a son?

Yes, I have a son, born two years after my marriage. He is now a lieutenant with General Pershing's army in France.

THE MAKING OF AN AMERICAN

*In the interviews previously published, covering the careers of distinguished members of the profession, we have had to deal with the mining and metallurgy of gold, silver, copper, and lead. In this issue we give our readers the record of a conversation with an engineer famous for his success in exploring for oil. It is a curious fact that people will talk of the finding and winning of oil as if it were not 'mining'; in an interesting controversy between two distinguished engineers it was contended by one of them that the exploitation of an oilfield did not come under the definition of 'mining'. Presumably the liquid condition of mineral oil and the fact that it is pumped, when it does not gush, suggests the notion that the art of extracting it from the earth is different from digging for ore. One might as well refuse to recognize hydraulicking and ground-sluicing as belonging to the ancient art, or, if that be stretching the analogy, then we may compare the winning of the liquid oil with the extraction of salt by solution in water, as a brine, or the raising of sulphur by melting it first with hot water. On the contrary, the finding of oil involves a more direct application of geology than ordinary metal mining, and the exploitation of an oil-bearing sand entails the application of engineering in its simplest and most direct forms, as we shall see in the interview with a notable exponent of this branch of technique. All those whose

*Editorial in the 'Mining and Scientific Press' of December 22, 1917.

careers have been reviewed recently in these columns happen to be Americans of British descent, that is, they connect themselves immediately or remotely with English, Scottish, or Irish ancestors; and only one was not born in the United States. Our subject this time is Anthony F. Lucas, a Dalmatian by birth, a Montenegrin by origin, an Austrian by forced adoption, and an American by choice. Starting as a cadet in the Austrian service, he happened to visit this country and became interested in the mechanical engineering of a lumber camp. Soon after arrival he felt the pull of this great democracy and decided not to return to his Adriatic home, which he re-visited only once, on the occasion of his honeymoon. Whatever the peccadillo that caused him to leave the Austrian navy, it is clear that he was not afraid to renew acquaintance with his former compatriots. He suggests that his immunity from arrest was due to the presence of his bride, and from what we know we can well believe that this charming and accomplished Georgian lady completely disarmed any official that might have thought of making trouble. After some experience of metal mining in Colorado and elsewhere Captain Lucas went to Louisiana to explore for salt. He describes the chamber-and-pillar system of mining adopted by him and explains how it is necessary to use brine in drilling for salt, in order not to enlarge the bore, as would happen if fresh water were used. He found an enormous mass of salt for the celebrated actor, Joseph Jefferson, who took a philosophic or grandpaternal view of the discovery, deciding to leave it for the benefit of his descendants. The salt was 1750 feet thick. Here we may mention the fact that scientific men are not yet agreed as to the origin of the masses of salt found in Louisiana. A post-Cretaceous movement of a deep-seated magma produced results not fully understood, because the igneous rock did not reach the surface save perhaps at one point on the Gulf Coast. It is supposed that the heated solutions ascended through the disturbed strata, which contained salt and gypsum. The solutions dissolved the salt. The force of crystallization enlarged the openings and the accretion of the saline deposits produced a doming of the strata. The final salt deposit is not a horizontal bed, neither is it a simple lagoon sediment or precipitate. Captain Lucas published a paper on his exploratory work at Belle Isle in the September 1917 bulletin of the American Institute

of Mining Engineers. Reference may also be made to an earlier paper by him on 'Rock Salt in Louisiana' in the transactions of the Institute for 1899. At Belle Isle, on the shore of the Gulf of Mexico, he discovered not salt alone, but sulphur and oil as well. Indeed, the subsequent exploiters of this deposit found that the salt was so impregnated with oil as to be unmarketable. The association of these three mineral products—salt, sulphur, and oil—is most interesting to the geologist, but space will not permit us to linger on it. We must hasten to the big event. Captain Lucas had now been prospecting and geologizing along the Gulf Coast for five years; going inland and exploring the Coastal Plain, he detected a mound at Beaumont in Texas. This mound indicated a dome, and the escape of sulphurous gas suggested that either sulphur or oil would be found underneath. So he leased the ground and started to drill, using a rotary tool, and therewith going safely through a layer of quicksand. At 575 feet he penetrated oil-sand, but almost immediately lost the well by collapse due to gas. He had saved a sample of the oil and with that sample set forth on a pilgrimage to obtain financial assistance. He tells us how he interested several well-known men and how others came to see him at Beaumont. He had spent all his money and was facing disaster at the moment when he thought he had justified his theory of dome structure. Experts of the Geological Survey and of the Standard Oil Company came to pat him on the back and dissuade him from so visionary an enterprise. He persisted, and at last obtained financial aid from Mr. J. M. Guffey. After spending $6000 more he struck oil and no mistake, a flood of oil that gushed forth with such violence as to hurl 1100 feet of casing and the head-blocks of the derrick out of sight. The oil gushed at the rate of 100,000 barrels per day; it made a 30-acre lake that overflowed to the sea, endangering both railroads and shipping. Thus the man that a few days before was facing bankruptcy now saw his wealth running to waste down the bayou. Then came the supreme test of engineering: to curb and control the flow of oil. Captain Lucas accomplished the feat by means of an ingenious device, which he describes, and thereby avoided the necessity for paying $10,000 to the woman that sent him a 90-cent collect telegram offering to do it by aid of absent treatment! It must have been more pleasant to receive the congratulatory message from the eminent oil

expert, but that gentleman did not liquidate his obligations thereby, for the discouraging advices of sundry 'savants'—that is what the daily press calls them, we believe—caused him, as he says, to "sell his birthright for a mess of pottage". The Lucas, or Spindle Top, gusher has produced over 50 million barrels of oil without giving a proportionate reward to the discoverer; but he had the satisfaction of proving his geologic hypothesis, and later he used his experience and reputation to get into some better-paying enterprises, and so, it is pleasant to record, he did not go unrecompensed. That recompense was not all in standard coin, for he acquired two things not measurable in common units; he gained fame and friends. His ideas and his work won him many friendships among geologists and engineers, who appreciate, among other things, the outstanding fact that he never succumbed to the importunities and blandishments of those that wanted to use his name for oil promotions. A big man physically, Captain Lucas has a big warm heart, spontaneously sincere and generous. Wholehearted in all he does, he is enthusiastic, even impetuous. Just now he is so keenly interested in the War and in the success of the great cause for which the Allies are battling that he will endure no half-hearted patriotism or tepid sympathy for the wrongs of Belgium or Servia, for example. The young Dalmatian that rejected the Austrian service to become an American has been splendidly consistent, not only in becoming a supremely useful citizen of the United States, but in sealing his devotion to the flag of his adoption by giving a fine upstanding son to the American army now fighting under General Pershing in France. The younger Anthony sets the seal on his father's Americanization.

JOHN H. MACKENZIE

AN INTERVIEW

Mr. Mackenzie, you are a native son?

No; I am a Canadian born at Toronto, Canada, on the 24th day of May 1858.

Was your father engaged in mining?

My father was a mechanic, and a good one.

What made you take to mining?

The lure of the West, and high wages.

What preparation did you have?

I had some schooling in mechanics and engineering—not a college course—in the high-school at Goderich, Ontario. When I was 13 years of age, I ran away to sea. I went as an ordinary seaman on a sailing vessel called 'The Mechanic', leaving the port of Detroit for Chicago; after that I made voyages from Chicago to Montreal, and from there to Liverpool and London.

How long did you remain a sailor?

Three years only. I decided that the sea did not offer me a career; I saw no prospect of advancement.

What next?

I went into the lumbering business at Muskoka, in Ontario, 200 miles north of Toronto. My work was scouting for timber, measuring and keeping accounts of the timber purchased for Gordon & Co. I had two years at that, learning to take care of myself in the woods. I also learned the difference between good and bad timber, besides having some experience in the wild life of the river.

It was a pretty tough life?

Indeed it was. That was why I left it, when the novelty had become well worn.

What date was this?

I quit lumbering in the spring of 1877, and in the fall of the same year I came west to Eureka, Nevada.

What brought you to Nevada?

Reports of men that had returned from there telling of the great mining camps of Virginia City and Eureka, which, at that time, were at their best.

Eureka, I suppose, was producing a great deal of silver-lead?

Yes, and gold also, for the surface ores contained nearly as much gold as silver.

Did you get a job?

I did. I went to work in the Jackson mine, as a miner, receiving $4 per day for a 10-hour shift. The work was done by hand, double-hand, that is, using both hands on a hammer while a partner held the drill. Another interesting point is that they were using black powder, although 'giant' had been introduced and was being used in some of the mines at Eureka.

Who was the manager of the Jackson mine?

William Shaw. He had been manager of the Eureka Consolidated, and he was owner of mines at Eureka until he died.

You were there for some time?

I was there for three years. The second year I worked as a timber-man, and the third year I was pump-man part of the time, and timber-man the rest. In the third year, when I was 23 years old, I was in charge of the timber-gang.

So you obtained some bedrock experience?

Yes, and I have been getting it ever since.

Do you recall any of your friends at Eureka at that time?

I knew Dr. Zeile, whose name is given to a well-known mine on the Mother Lode, and Hank Donnelly, who was a famous superintendent at Virginia City; also Charlie Canfield, who died three years ago, and was a big operator in oil, associated with E.

L. Doheny. Canfield was shift-boss when I was timber-man in the Jackson mine. I also knew Tom Reed, superintendent of the Eureka Consolidated mine and smelter, and your uncle, Reuben Rickard, who was then superintendent of the Richmond; also John A. Porter of Denver. In fact, my next move was due to Mr. Porter, for he engaged me to go to Colorado as timber-man in the Aspen mine at Silverton.

What sort of a mine was that?

Native silver ore; the vein was worked by adits entirely, the ore being treated locally at the Greene smelter. They charged from $75 to $100 per ton for smelting, not to mention other deductions, so that the smelter made money, and even the mine, because the ore used to run from 150 to 300 oz. silver per ton.

You did not remain timber-man long, I suspect?

About eight months. The Black Range excitement broke out in New Mexico, and I stampeded, going on snowshoes to Durango, then by packhorse to Santa Fe, and from there down the river to Socorro.

What did you find there?

Many promising prospects; but I did not stay, the danger from the Indians being greater than the prospects of making money, although Chloride Gulch became quite a camp afterward.

When did you return from New Mexico?

I did not return; I kept going. I went down to Tombstone, Arizona, and into the Chiricahua range, where I prospected for silver and located some silver-lead claims. This was the spring of 1881. I spent some time in several mining camps in New Mexico, such as Silver City, Georgetown, Santa Rita (which is now Chino), Shakespeare—by the way, Henry C. Callahan was there at the time, and so was Doheny.

You did not find anything good?

No, but I sold some claims and made a small stake, selling five claims for $5000, which seemed a lot of money to me then. With that I went back to Tombstone, in the fall of 1881, the year in which President Garfield was shot. At Tombstone, I was ill

for a time with rheumatism, and then I came to San Francisco, where I regained my health.

By this time you were only 24, but you were more than a sophomore in the college of experience?

I thought I knew a great deal more than I really did. I found afterward how little I knew at that time but I was full of confidence and ambition, and I had become tremendously interested in the work of mining.

What was your next step?

I went back to Eureka a second time. The Eureka Consolidated was putting down a large new shaft, and erecting a big plant of hoisting machinery and a large hydraulic pump. I went to work for the company, taking charge of a gang of men engaged in installing the new machinery. After the machinery was in place I had charge of the pumping plant from the time it started in the fall of '82 until it shut-down. For two years they kept sinking the shaft and fighting the water, so that I was fully employed and obtained some valuable experience—some of the best experience that I have ever had. The mine became flooded, and the camp practically idle, so I took a lease on the Hamburg mine above the Dunderburg, north of Eureka.

How much money did you put in?

We put in very little money, but a lot of work. We made some money, shipping our ore to the Richmond and Eureka Consolidated furnaces, and then cleaned up. From there I went to Butte, Montana, which was then, in the fall of 1884, on the boom.

What did you do at Butte?

I worked as timber-man for Alfred Wartenweiler, who was manager of the Lexington mine. After a few months I took a lease of the Lavina mine at Burlington and the old Silver Boy 10-stamp mill. I was in partnership with Neil McSherry. We made some money, but the vein played out in depth, and, owing to the excessive flow of water, we could not afford to prospect further. I then went to work for W. A. Clark in his concentrator at Meaderville, and put all the machines there in shape. I was there about four or five months. I knew many of the old-

timers, Patsy Clarke, Mike Carroll, the famous superintendent of the Anaconda, Daly's right-hand man. I also knew Jim Murray, besides Marcus Daly himself, but only casually.

What sort of a place was Butte then?

At that time the roasting was done in heaps in Silver Bow flat, and the air was loaded with sulphurous smoke, so that at times people on the street could hardly find their way. The Lexington was down only 450 ft. and Anaconda was only 800 ft. deep. Silver was an important part of the output, in addition to copper.

From Butte you went whither?

The smoke made my throat so sore that I decided to seek a purer air, and went to San Francisco, remaining there about two months. I was offered a position as foreman of the Jackson mine, the one in which I had first worked. I accepted; that was in '86.

You ran the mine for how long?

Two years. I then leased what was known as the Ruby Hill water-works, from Walter Harrub, a famous character in the early days of Nevada. I ran the water-works for two years, but you must not think that there was no mining connected with this job; the tunnels for tapping the water were always caving, so that I was kept busy maintaining them in proper repair. Eureka became very dull again, so in 1891 I went to the Black Hills in South Dakota.

Did you have an appointment?

Yes, with Franklin R. Carpenter. I had obtained some sort of a reputation as a pump-man and a miner experienced in handling water, thanks to my work at Eureka. Dr. Carpenter ran the old Delaware smelter and had several mines in the district, among the number being the old Oro Fino, which was full of water at this time. They were trying to pump it out. It was about 12 miles from Deadwood. I was superintendent of that property for about two years. The price of silver went down so much in the crash of 1893 that work was stopped.

It seems to me, Mr. Mackenzie, that you and I are in agreement in one respect. I used to think that a young man could always get all that there was to be learned at any one mining camp in the course of two years. It seems to me that your periods were nearly always two years.

Yes, I made it a point never to stay longer than two years in one camp.

On leaving the Black Hills, where did you go?

I had heard of the Cripple Creek excitement, and went there, meeting W. S. Stratton, the discoverer of the Independence. I found him prospecting on the surface of Battle mountain. He told me about his discovery, it seemed to be interesting. He wanted to know if I knew how to run a mine; I told him that I could, and, without any further recommendation or acquaintance, he engaged me on the spot. I gave him references, but he never made use of them. He had had six superintendents during the previous three or four months.

That was the time when I first met you?

Yes, I remember a visit that you made with Mr. Tom Stearns to the mine in December '93, when Cripple Creek was having its first boom. The Independence shaft at that time was only 100 ft. deep and the Washington shaft was 60 ft. deep, with a tunnel uniting them. We were raising the ore with a whim, stoping above the connecting level, and shipping the ore to Denver. I re-started work on the Independence shaft, and kept on sinking it until it was 600 ft. deep. The Independence vein proper was in granite and the shaft was situated near the contact between the granite and the porphyry, hence the vital question at that time was whether the vein would continue into the porphyry. When I first came the ore was averaging five to seven ounces per ton for a width of five to seven feet.

What smelter rates did you pay?

I think on 5-oz. ore the smelter and freight rates combined came to $15 per ton.

What sort of a man was Stratton?

A man with a keen mind, but not well balanced. In business

he was liberal and fair, but suspicious; he trusted very few people, changed his mind often, and did not understand handling the large sums of money that he was making not only out of the Independence, but also out of the Portland, of which he owned one-fifth. He was charitable. In his investments he was often foolish, and many people took advantage of him.

He was not a man of any technical training?

No, he was a good millwright, and had prospected quite a lot, especially around Silverton. His finding of the mine was a matter of luck. He was prospecting on the sunny slope of Battle mountain and he saw the outcrop of the Independence vein, but it looked very much like granite. Several other people had seen it and concluded it was nothing but decomposed granite. All of them passed it by. Stratton himself found that the loose porphyry-rock on the hillside contained gold, but he could find no vein. Finally he chipped off a piece of the granitic outcrop and looked at it through a magnifying glass, detecting some rusty gold. Thereupon he broke some more pieces and had them assayed at Colorado Springs. The sample contained 19 oz. gold per ton!

So you had the pleasure of starting the development of one of the big mines of the world. Did you remain long with Stratton?

Three years. Then I went on a vacation, and while I was away the meeting of the Portland directors took place. They were having trouble with water in the Portland shaft, and at the meeting of the board, the directors, who were quarreling, agreed to offer me charge of the mine. I accepted. The offer came to me by telegram while I happened to be in San Francisco on my vacation. I returned next day, as they accepted my terms right away. I took charge of the work at the Portland for just about a year.

Then you knew James Burns and John Harnan too?

Very well. At that time Jim Doyle, another owner, and Jimmie Burns were at dagger's points and when they came to the directors' meetings—I was also a director—Doyle would come with the handle of a six-shooter sticking out of his coat-pocket,

and Jim Burns was supposed to carry a gun in his hip-pocket. It looked like a battle every time they met; I always expected that one of them would kill the other, but no gun-play ever followed, I am glad to say; for my life, incidentally, would probably have been jeopardized also. Stratton used to sit back in the corner with his hand on the gun in his trousers' pocket. Yes, indeed, those were lively times! Stratton himself used to laugh at Doyle and Burns; he was absolutely fearless. The affair ended in a long-drawn litigation and in Burns getting the control, which he afterward lost to Howbert and some of the others.

Why did you leave the Portland?

On account of these rows and bickerings. My engagement was only for a year, so when the year elapsed, I went to the Yukon. That was in 1898, the year of the big stampede. Stratton was interested with me in the venture. I took six assistants with me, and sent them ahead over the ice to Dawson, following them myself in the spring of '99 on the old steamer 'Leelannaw'. She was torpedoed recently by the Germans.

That must have been an exciting episode?

It was; a big mob of people was going to the diggings. Most of them did not know what they were going to do. I went by water to St. Michael, and up the Yukon to Dawson, so that I missed the horrors of the White Pass. Arriving at Dawson, I saw a great crowd of people camped on the river, a town was being built rapidly, warehouses were going up—the usual excitement of a mining camp; but I did not stay long in Dawson. I went out on the creeks, and stayed there for nearly a month, tramping around and investigating. Finally I bought some claims on Bonanza creek, between Fox and Monte Cristo gulches, and extending down to Bonanza. I also started a survey up the creeks, with the idea of building a railroad. I sent men among the diggers to check off the amount of freight that was coming in, to find out what it was costing. The profit to be made on 60-days freight would have paid the cost of a narrow-gauge railroad. I took the plan to Ottawa, but I could not get a charter without giving the greater part of it away to political graft-

ers. It was two years before we got the charter, and by that time the interest that was left to Stratton and myself was only 36%, 64% having gone to the Ottawa lobbyists. I regret to have to say that at that time Canadian politics was thoroughly rotten.

Did you return to Dawson?

From Ottawa, yes. I went in over the ice from Skagway with a dog-team. That was in March 1899. At that time Dawson had become more settled; they had built better trails up the creeks; the claims were being worked systematically and with intense energy. I worked my claims for two years, and then sold them at a profit of $65,000, of which Stratton was entitled to half, but he refused to take any of it, so that I got all of it, thanks to his generosity. I sold because I had decided that I did not want to live there. The winters were too cold and the work required too much supervision. Incidentally, I must say that I was one of the first to recognize the usefulness of steam-thawing and to use it. After selling my claims, I came out to Seattle and bought all the small boilers I could find in Seattle, Tacoma, Portland, and Vancouver. Altogether I got about 35 small boilers, some small hoists, thawing-tools, pipe, and so forth, and shipped them into Dawson.

You made money over that?

I cleared about $50,000 out of that deal.

Speaking of thawing do you refer to the use of steam-points?

Yes. At first the people on the creeks used to take empty gas-tanks, the kind used for charging soda-water. They were about 6 inches in diameter inside, and about 5 ft. long, standing a pressure of probably 1000 lb. per square inch. Then they drilled dozens of little holes about ¾ in. all around them, cut off short pieces of pipe, about a foot long, welded one end, cut a thread on the other—so that they played the part of tubes in a tubular boiler—and screwed those short pieces into the boiler, then admitted feed-water near the bottom and drew steam at the top. The tank or miniature boiler was set on end, enclosed in stones cemented in mud, and a fire was built at the bottom. The steam thus generated went to the 'points', which

were steel pipes with a solid piece of steel welded at the front end so that they could be driven into the ground like drills.

What did you do next?

I went to the Mariposa grant for Wernher, Beit & Co. I had become acquainted with Hamilton Smith during a visit that he made to Cripple Creek to inspect the Independence mine. When the British financial firm purchased the Mariposa grant from the former owners (the trustees of the Alvinza Hayward and J. P. Jones estates), Hamilton Smith asked Capt. Thomas Mein to look me up, and the latter then offered me the position of manager of the grant, which included a group of five mines that had been worked in the early days by John C. Fremont.

Yes, I happen to know about that, because my grandfather, James Rickard, came to California in 1850 to examine the Mariposa grant in behalf of the firm of John Taylor & Sons. The grant had been placed in London by General Fremont, known in romantic history as the 'Pathfinder'. My grandfather brought a sectional stamp-mill from Cornwall, and made a thorough test, the result of which was an adverse report. Of course, at that time, the cost of mining was high, and a low-grade mine that might be highly profitable today would not be worth looking at 66 years ago.

That is true, but we also found the ore left by the old-timers very low-grade. After pumping the principal workings, we found no ore that would pay even with the present methods of mining and milling. The best ore left in the Princeton—the principal workings—assayed only $2 per ton. Our predecessors had worked out the ore that was profitable to them and a good deal that left no margin, but after extensive development work we found good ore below the old workings.

Do you think that there is any chance of successful mining on the Mariposa estate?

Yes, I do. We sank below the lean zone, and found good ore between the 600-ft. point where the old company stopped

and the 1000-ft. level of the Princeton. We had long and wide stopes of good ore.

How good?

To the best of my recollection it ran from $4.50 to $5 per ton. I might add that there was also in one mine, the Mariposa, some profitable ore that the old company had left because it was so hard that it could not be stoped profitably without machine-drills, which were not in use at the time mentioned.

How long were you there?

I was on the Mariposa grant from 1899 to 1901, and I left owing to the offer of the management of the Le Roi mine (in British Columbia) and the Northport smelter. The offer came to me through R. J. Frecheville. At that time Mr. Frecheville was examining the mine, and the Le Roi Mining Co. had been the victim of Whitaker Wright's operations, being indebted to the Bank of Montreal for some half-million dollars. Whereupon the bank had insisted on an examination by Mr. Frecheville, and on a reorganization of the management; so I went there in November 1901.

You found things in bad shape?

Yes. The Northport smelter had been badly handled. There was 80,000 tons of copper ore in the roasting-yard that would barely pay the cost of smelting. This had been done apparently to boost the stock. Whitaker Wright left things in a sad mess.

You would not condemn the British management of mines wholesale?

Certainly not. I have seen as many mines managed conspicuously well as conspicuously badly by English companies, and, after all, the local management at Rossland was not British. However, I do recognize the difficulty of managing a mine in the United States when the board of directors sits in London, and is wholly unfamiliar with the local conditions. The only remedy is for the directors to place authority in the hands of a competent resident manager, and they must give him a pretty free hand, otherwise he is severely handicapped by the delay in getting permission to do things, and by the uncertainty as to

which individual is in control at the other end. Business that requires instant decision may have to wait for weeks.

What sort of an experience did you have at Rossland?

There was a strike on at both the mine and the smelter when I arrived there, making it rather difficult for the first few months, but at the end of a year we had paid off nearly all the debt to the Bank of Montreal, and the affairs of the company improved daily. At the end of two years, when I left there, we had about $460,000 in the treasury.

What happened then?

Then I resigned, as I wished to return to the United States.

What next?

I joined F. W. Bradley, here in San Francisco, in the work of examining and managing mines, and we continued to do that for several years. Between 1903 and 1905 Mark L. Requa joined Bradley and myself, and we did a general consulting business. At that time Requa had an option on what is now the Ruth portion of the Nevada Consolidated. Bradley and I joined him in the enterprise. All of us spent a good deal of time at Ely, and made the necessary tests, by drilling and milling, to determine the value of the property. Requa was in direct charge of this work, which led to the organization of a company, by James Phillips and W. Hinkle Smith, called the White Pine Copper Co. That was in November 1904. Out of this and the Boston & Nevada Copper Co. grew the Nevada Consolidated, which has proved such a splendid property.

You made some money out of that?

Yes, we all made money, but we had to surrender control owing to the fact that our Eastern friends insisted on selling to the Guggenheims. Still, we did very well.

Are you still interested in the Nevada Consolidated?

No. We have gone into a lot of other things since.

What was your next venture?

I went back to the Le Roi in 1905, with R. W. Brock, of the Dominion Geological Survey, for the purpose of appraising

practically all the large mines in the Rossland district, including the Centre Star, Le Roi, War Eagle, also the St. Eugene at Moyie, and the Trail smelter, for the purpose of an amalgamation planned by Sir Henry Tyler, who was chairman of the Le Roi company, but this amalgamation fell through, owing to the hostility of A. J. Macmillan, who at that time represented the minority shareholders and subsequently became managing director.

When did you become manager of the Goldfield Consolidated?

In 1907. The management was offered to me on the initiative of William H. Crocker, in association with Senator Nixon, the partner of George Wingfield in his mining ventures.

You had a lively time while at Goldfield?

Yes; four days after I arrived there a strike was called, and the property was shut-down for a time. I was glad of the shut-down because it stopped the stealing of ore. Up to that time the Goldfield Consolidated had only a small mill and was shipping a great deal of ore to Salt Lake, paying high railroad and shipping rates, as well as excessive reduction charges. The strike gave us time to build a mill of our own, which we did, commencing in January 1908, and finishing in December of the same year. This was a 100-stamp mill, capable of treating about 600 tons a day; afterward a Chilean mill addition was put on, and the plant was raised to 1000 tons per day capacity.

Mr. Mackenzie, you have been in charge of a great many mines, and have come in close contact with the working miner. What do you consider the main cause of trouble between the companies and their men?

The walking delegates, and the lack of co-operation between the management and the better class of their men. As a matter of fact, while I have been through three strikes, I have prevented a great many strikes by calling the better class of workmen before me and talking in a friendly manner with them, making an effort to show them that the company or its management had no desire to take advantage of them, but, on the contrary, was trying to be fair to them. Usually this kind of argument, especially when really true, would always be listened to with respect.

Do you recognize the right of unions to act together; in other words, for the local union to join with unions in other districts in making a demand?

I recognize their right to do so, but I do not believe it is always the best policy for either the mining companies or the unions to join large organizations that have nothing in common with the particular work or other local problems, but I do recognize the right of combination, and of collective bargaining. We all do it.

I take it, however, that you do not regard the Western Federation as a union within the law?

Certainly not. I do not recognize the Western Federation as a good friend of the Western miner. I do not approve of their methods of gaining their points. I do not believe that they have helped to further the just demands of our Western men. In the early days of Nevada, the miners' unions of Eureka, Virginia City, and White Pine were organized as locals, and as individual unions they gained more advantages from the mining companies than the Western Federation ever gained afterward by their methods of intimidation.

How long were you at Goldfield?

As manager I was there a little over two years. For two years longer I was consulting engineer and director, that is, until the early part of 1912.

You returned to consulting practice in San Francisco?

No. All three of us—Bradley, Requa, and myself—were so absorbed in enterprises in which we had placed our own money that we did not look for clients. However, my work at the Alaska Juneau has been of a consultative kind.

When did you get into that?

Bradley had been connected with the Alaska Juneau for many years, and in 1910 Requa and I joined Bradley in driving the new adit and other work, for which we received a block of shares out of the treasury of the company. Subsequently

we, together with Mr. Crocker, purchased the Wernher-Beit interest in the Juneau property, so that we obtained control.

You made a report on the mine in 1915, I believe?

Mr. Bradley and I made a joint report, estimating 80 to 100 million tons of ore to be mined and milled. Given sufficient money to develop and equip the property we estimated a profit of $1,400,000 per annum as reasonably assured. On this report we sold 400,000 shares of the treasury stock, netting the company $8 per share, a large block being taken by B. N. Baruch and associates.

Mr. Mackenzie, I am going to ask you a question that may be difficult to answer. To what extent do you think these enormous bodies of low-grade ore can be sampled?

My personal opinion is that the usual methods of sampling are of no use in such orebodies. You have to carry out the test on a milling scale, that is, crush thousands of tons and take samples right across the vein, quite similar to a moil cut, and, in addition you have to take it at different levels on the orebody. We milled 50,000 tons from across the orebody lying north of the Silver Bow fault, and we based our calculations on the value of the ore north and west of Silver Bow on that mill-run. On the south-east side of the Silver Bow fault, adjoining the Alaska Gastineau property, we based our calculation on about 480,000 tons of ore that had been mined and milled during the life of the Alaska Juneau, prior to and after our acquiring control.

Can you find out the number of raisins in the cake without eating all the cake?

No. Absolutely, No. Therefore, even sampling on this scale is only an approximation, but it's as close as one can afford to go.

Of course; if you take more out, you may as well take all out, and the sampling becomes an exploitation on a large scale, and ceases to be sampling.

We are compelled to take some risks on sampling and estimating orebodies similar to those on Douglas island and in the Alaska Gold and Juneau mines. Our calculations are based on

estimates that may vary considerably when we come to take the ore out.

You have faith in the outcome of the big operations at Juneau?

I have. I believe the Alaska Juneau will earn the dividends that Mr. Bradley and I predicted, namely, $1,400,000 per year.

Have you formed any opinion about the prospects of your neighbor, the Alaska Gold Mines?

I have not been through the mine for over two years. At the time of my last visit, it looked to me that they would make good on their estimates of producing a net profit of 75 cents per ton. Since that time I understand that they have had some difficulty owing to the hanging wall of the vein caving and mixing with the ore, resulting in reduction of grade. While they may not be able to earn 75 cents per ton net profit, I believe they will be successful in earning a substantial profit—a profit that will justify them in their original investment on the property.

By the way, Mr. Mackenzie, you are one of those that profited from the rise in tungsten, I believe.

Yes, I have an interest in the Atolia mine, together with my friends, Mark Requa, Fred Bradley, Baruch, Stent, and Voorhies. While the price of tungsten was soaring, we made some nice dividends.

Are the technical operations interesting?

The Atolia ore is scheelite associated with quartz in a fractured zone through granite. The vein is faulted and twisted so much that it is very difficult to follow it. The interesting thing about tungsten is that none of the producers are using the soluble treatment of it. The Germans have been doing it for years, and we are planning a soluble-treatment plant and refinery, and have decided to erect one at Atolia. At the present time we mine the ore and transport it to a mill that will treat about 65 tons per day, crushing and concentrating in a manner similar to lead and copper practice, and making a concentrate containing from 50 to 75% of scheelite. We ship it to the Eastern markets, where it is bought by the tool-steel makers and the electrical-equipment companies.

So the Atolia is a war-baby?

The price of tungsten went up from $7 per unit at the outbreak of the War to $75. The price is now between $15 and $18 per unit and we anticipate a still further reduction when peace is declared.

Do you expect to operate profitably when peace is declared?

We do, because we believe that we can operate the Atolia mine and produce tungsten as cheaply as any other mine in the world. If the price goes to $10, we shall be able to make a fair profit, and we have every reason to believe that it will not go below $10, because a great many new uses have been found for tungsten during the period of the War, and the known sources of supply are limited.

From what episode in your career do you derive the most satisfaction?

There are several episodes that I believe gave me equal satisfaction. Developing the bonanza orebodies in the Independence and Portland mines, the pulling of the Le Roi company out of debt and putting it on a sound financial basis, the opening up and developing of the tremendously rich ore deposits of the Goldfield Consolidated group of mines, together with the building and putting into successful operation of the Goldfield Consolidated mill within a period of eleven months gave me a great deal of pleasure and satisfaction.

Do you consider mining a good career for the young American of today?

I believe there is a good field for trained underground superintendents or foremen. Trained men are difficult to find and are always in demand. In order to fit himself to be an underground foreman, a young man must spend several years as a miner, timber-man, and shift-boss, and if he has the physique together with the courage and patience to gain the necessary experience, I think his services will always be in demand at a good salary.

Do you believe in the adoption of concentration in lieu of amalgamation and cyanidation in the treatment of the low-grade ore at Juneau?

After several months experimenting with a 50-stamp mill

at Juneau, with and without amalgamation, we demonstrated that the tailing loss was no greater using concentration alone than when using amalgamating plates prior to concentration, and the cost was slightly less. The average ore in the Juneau gold belt is too low in value to bear the expense of cyanidation.

What methods of mining do you consider best for wide bodies of ore separated by considerable thickness of poor ground?

No fixed method can apply to all, as so much depends on the nature and value of the ore deposit and whether the walls, or boundaries, will stand, or are soft and likely to cave. As a rule the poor bands can be left in place or used for filling. Where ore is of good grade, square sets and filling will give the largest percentage of ore-recovery and the best control of stoping. Where an orebody is large and lean, the loss of ore is not so vital and some system of caving or shrinkage may be the most economical.

What are your views concerning the proposed changes in the mining law? I refer more particularly to the abolition of the extra-lateral right and the requirement of discovery before location.

Our present mining laws have been the cause of expensive litigation in the past and appear to me to be more beneficial to the legal profession than to the owners of mines. Senator Smoot's bill withdrawing the extra-lateral right from future locations is a step in the right direction, but locations already made under the extra-lateral law should be left undisturbed as most of them have already settled their differences in court. In British Columbia claims are staked 1500 ft. square with no extra-lateral rights and the boundary monuments are placed by competent men appointed by the Government. Rossland furnished a good example of the operation of both the extra-lateral law and the square location without that right. The first locations made in this district had extra-lateral rights, which were the cause of expensive litigation, and expert lawyers and geologists from the United States were imported to try some of the cases. The law was repealed and locations made without extra-lateral

rights, the result being that there has been no serious or costly mining litigation over the later locations.

How about the requirement of discovery?

The question of making a discovery before location has many sides to it. Where outcrops carrying ore exist, the law works no hardship on a prospector, but the porphyry copper districts would have experienced many difficulties if discovery before location had been strictly enforced. At Ely, Nevada, the operating companies purchased from the original locators many claims that had been held for several years without any real discovery. Some of these claims, I feel sure, never have had an exposure of ore on the surface, but today all are patented. Where no actual outcrop exists and the geological features indicate the possibility of valuable orebodies underneath, the prospector or mining company should be given a prior right to prospect without a discovery and be allowed ample time to sink shafts and demonstrate the value of the territory located.

What do you think of Albert Burch's suggestion to give instruction in mining to American young men at the mines and at the instance of the operating companies?

I fully approve of Mr. Burch's suggested plan of giving free instruction in mining to worthy young men at the expense of large operating companies. Like Mr. Burch, I have seen the young Americans and the strong sturdy men from Cornwall, Ireland, Scotland, Nova Scotia, and Canada gradually disappear from our Western mining camps. I think it is safe to say that in the year 1878 fully 95% of the miners in Nevada came from these countries, and a more intelligent and capable lot of men could not be found anywhere. Many of these men were competent to fill the positions of timber-men, shift-bosses, or foremen. Today the young Americans do not care to spend several years at hard work underground competing with foreigners, many of whom cannot speak English, but I believe that if the companies engaged in mining would furnish schools and teachers that woud educate and fit the beginners for the better paying positions and, when deserving, give the men so trained a preference, it would induce the young men to stick to their jobs and thereby gain the necessary experience to fit them for

the positions they knew would be within their reach, provided they proved worthy.

A SUPERINTENDENT OF MINES

*Mining is full of romance, but much that passes for such is tawdry fiction. The accidental discoveries of rich ore made by ignorant men to whom wealth brought merely the opportunity for unlimited debauchery are often allowed to masquerade as romance, and the piling of millions by unscrupulous gamesters is not infrequently glorified into masterful finance. In this issue we publish an interview with a real miner, and in the course of that interview he, John H. Mackenzie, gives us the outline of an adventurous career. The story is truly romantic because throughout there is disclosed the development of character and the growth of natural abilities that were put to useful purpose, culminating in wealth—of course—but also in things much more difficult to win—the reputation for engineering skill and the goodwill of his fellow-men. From the boy that ran away to sea and then penetrated into the lumber camps; from the youth that heard the call of the West and the resolute man that braved the perils of the Klondike rush, we see emerge the captain of industry. From his father, who was a mechanic—"and a good one"—he inherited some liking for machines and the working of them, for he himself was a good mine-mechanic before he was a miner; he became an efficient timber-man and an expert pump-man, and through these fundamental experiences he learned to understand the more complex machinery of the mine and mill, so that in early manhood he was well equipped to direct the multifarious operations of a big enterprise. We are not of those who believe that every graduate student in mining engineering should devote several years to manual labor underground, simply because we know that many youths have not the robust physique —the toughness—necessary for the performance of such work without at the same time dulling their mental faculties, but we are among the first to acknowledge that if a young man has got the spirit and stamina to undergo this severe training he will emerge a more capable leader of men. Mr. Mackenzie under-

*Editorial in the 'Mining and Scientific Press' of January 27, 1917.

went such a training, and in consequence of it he acquired a thorough knowledge of basic operations underground; he had the nerve and strength to go through the hard grind of physical labor and of junior supervision, thereby gaining a closer understanding of the realities of mining work than is the portion of the young man that graduates to superintendency or management from the assay-office or the survey department. Few, if any, of those at the top of the mining profession have so intimate a knowledge of conditions underground. Moreover, the close contact with the drill-men, the shovelers, the trammers, and the timber-men has given Mr. Mackenzie an appreciation of the human factor, which is at least as important as the mechanical. That was demonstrated in his successful handling of the strikes at Goldfield and at Rossland. He obtained 'bedrock' experience early and, as he says, he has "been getting it ever since".

When he went to New Mexico and the Indians stood in the way, he did not return, but "kept going". When only 23 years old he sold some mining claims and first acquired the feeling of financial independence. His wanderings in Arizona, New Mexico, Nevada, and Montana did not lead anywhere in particular, but the engineering done on the water-works at Eureka gave him a reputation as a pump-man and led to his first charge of a mine, near Deadwood. Soon came the lure of Cripple Creek and the meeting with Stratton. That was a decisive event in his life. As that versatile poseur Thomas W. Lawson has said: "Fate hangs no red lights at the cross-roads of a man's career". Stratton stood at the right turning, and from that moment when Mr. Mackenzie was engaged by him as superintendent of the famous Independence mine he never looked back. His story of the discovery made by Stratton is in accord with our knowledge of the facts and quite different from the fanciful tale that reporters and others concocted when once Stratton became a millionaire. Those Cripple Creek celebrities were an unlovely lot, but Stratton knew how to be generous and the story of his dealings with Mr. Mackenzie does honor to his memory. The squabble between the first owners of the Portland is not enchanting and the use of revolvers only provokes a sarcastic smile, for these antics of the directors of a big mine were childish and stupid. A whiff of the fresh strong air of the Far North comes across the

Federation of Miners. He approves Mr. Albert Burch's plan to aid young Americans in obtaining instruction while working at mines; in this and in kindred matters of management he exhibits a humaneness that we know to be no affectation. As to the Alaska mines and sampling, that is a subject much too big for passing comment. We would like Mr. Mackenzie and Mr. Bradley to follow their excellent report on the Alaska Juneau by writing a paper on the subject of sampling big bodies of low-grade gold ore, but the trouble is that those that know about these matters are disinclined to write on them. To such broad-gauge men, however, the public service performed by such a writing ought to be a real inducement. And so we leave our 'superintendent of mines' actively engaged in big-scale digging, of gold at Juneau, of tungsten at Atolia, and of other metals elsewhere. The interview will be read with pleasure beside many a campfire and cabin-stove, for John H. Mackenzie has spread his friendships all over the West. A man of engaging personality, of unaffected good-fellowship, and possessed of the saving sense of humor, he has made friends from the sturdy timber-man stepping into the cage for his day's shift to the 'malefactor of great wealth' ensconced in the soft upholstery of a limousine gliding over the asphalt to Wall Street. His success has pleased all of them, for, by birth a Canadian and by life an American, he is the kind of true democrat that socially knows no superior and likewise no inferior. Mining still offers a career to talent. It affords great chances to those that work hard and 'make good'. That is the moral of this story.

EDWARD P. MATHEWSON

AN INTERVIEW

Mr. Mathewson, you are a Canadian?

Yes, I was born at Montreal on October 16, 1864.

Where did you get your early education?

At Montreal, in private schools and the high-school, graduating from McGill University in mining engineering in 1885, as Bachelor of Applied Science.

Was your father connected with mining or metallurgy?

No. He was a wholesale grocer at Montreal, and his father before him.

What made you take to metallurgy?

Intuition, I think. It fascinated me. My first impulse toward metallurgy came when looking at some models of furnaces in the college at McGill. When I entered McGill I did not know what course I was to follow, and went through the first year without making a decision.

What was your first job?

I was a surveyor on the Dominion Geological Survey, surveying lakes in Ontario under Eugene Coste. He was head of the party; A. R. C. Selwyn was head of the Survey at that time; my immediate superior was E. H. Vautelet.

Did you remain with the Survey long?

Just for the summer; then I killed time around my father's establishment during the winter months, and the following spring I decided to go to Colorado. I did not know anyone in Colorado, so I asked my old professor of chemistry, Dr. B. J. Harrington, if he knew of anyone in the West. He referred me to T. Sterry Hunt. Dr. Hunt received me most kindly, at his residence in Montreal, and told me that he knew of one of his former pupils

general move up; Baron de Ropp was made chief metallurgist, my old chum Engelhardt became his assistant, and shortly afterward the Baron, then 'Tommy' Ropp left, and Engelhardt became chief metallurgist, and I was promoted to be his assistant. Within a few months de Ropp went to Anaconda to take charge of the lower works there, and sent for Engelhardt to act as his assistant, thereby creating a vacancy, to which I was promoted.

By that time your salary had been increased?

Up to $150 per month. I made some slight remonstrance with the manager, Foster Nichols, and after some correspondence with the Boston directorate my salary was increased to $250 per month, but that included the supervision not only of the lead-silver smelter but the copper department as well, the head of that department, William Foster, having resigned.

What was your copper process?

It was the Crookes process, whereby the matte from the lead blast-furnaces containing a certain amount of copper was desilverized in a series of reverberatory furnaces, in each of which there was a bath of molten lead. After desilverization the matte was given an oxidizing roast, to form what was called 'moss' copper, the name coming from the fact that the metallic copper appeared on the surface of the roasted material in a form resembling moss. This moss-copper was then treated in blister-furnaces and the blister put into a refining furnace, to be treated by the old Welsh method.

Can you recall any of the figures of cost in those days?

My recollection is that the cost of producing copper from matte by this process was something like $40 per ton of matte.

What was the cost of your lead smelting?

In the neighborhood of $4 per ton of ore.

The smelting was done, I presume, in furnaces of the Piltz type?

No. The furnaces were of the Rachette type, using coke from Trinidad, mixed occasionally with wood-charcoal. We had water-jackets of cast-iron, and we had two wonderful furnaces, 5 ft. by 8 ft., with water-cooled tuyeres projecting inward six inches on each side. When the ore was free from fine, these

furnaces would smelt over 90 tons of charge in a day, which was considered impossible by the fraternity, and doubted by our competitors.

Your ore was mostly from Leadville?

Yes. A little of the copper ore came from Salida. Not much of the ore was treated as strictly copper ore. Some of it came from the San Juan and Clear Creek.

What caused you to move from Pueblo?

In 1897 Ben Guggenheim, of M. Guggenheim's Sons, offered me the position of superintendent and metallurgist of the Philadelphia smelter at Pueblo, which had been built nine years before in conjunction with Ed. Holden, backed by the money of Meyer Guggenheim.

That smelter also was at Pueblo, was it not?

Yes, but I remained there only a short time. I had hardly been appointed when Ben Guggenheim asked me to select my successor and prepare to go to Perth Amboy to manage their lead and copper refinery at that point. I selected R. D. Rhodes, of Leadville, and we made the necessary arrangements for him to take my place. Three months after my appointment as superintendent of the Philadelphia smelter, I was moved to Perth Amboy.

Did the Philadelphia smelter present any remarkable features?

It was considered a large smelter at that time, and the bedding system—the mixing of the ores in beds—was very carefully done by hand, from tram-cars, so that the charge was fairly uniform on the furnace. They had external crucibles and other fancy stuff when the plant was first started, but these innovations were discarded in favor of standard practice.

You found your new post at Perth Amboy interesting?

Yes. This plant was a large lead and silver refinery, for its day, and had the Mœbius method for parting gold and silver. This was an electrolytic method, the silver crystals being deposited either on silver belts or silver plates from a nitric acid solution, while the gold was collected as a mud in canvas bags, the anodes being in the bags themselves. We built some of the largest lead-

refining furnaces in existence at that time. They were capable of holding 100 tons of lead at a charge. They have furnaces two or three times as big now, at the same plant.

How long did you remain at Perth Amboy?

I remained there until September of 1897, when I was sent by M. Guggenheim's Sons to Monterrey, Mexico, to succeed the late O. H. Hahn, superintendent and metallurgist of a lead plant there. We treated oxidized ores from the Santa Eulalia, Santa Barbara, Angangueo, and Catorce districts in northern Mexico.

Was your practice remarkable in any way?

One notable feature of the plant was the use of gas-producers for firing the roasters. We made our gas from Coahuila coal, otherwise we would have had to import coal from the United States. The limestone was all hauled from Topo Chico, a distance of a few miles, by ox-cart.

You found it pleasant to be in Mexico?

It was pleasant so far as the climate was concerned, but the labor conditions were peculiar. At that time, on the least sign of rain in the afternoon, the night-shift would fail to show up. We would then send our trusted watchman to scour the town and round up as many Mexicans as he could, and we would put them to work, but every evening we had to count noses to see how many furnaces could be run through the night. Another peculiar feature of the labor at that time was the utter indifference of the Mexican laborer to the company's interest. If a tap-hole broke out and the hot slag ran over the floor, instead of endeavoring to stop it, the peons would dance around the hot slag, like a lot of wild Indians in a sun-dance, until the furnace emptied herself.

How long did you remain at Monterrey?

Eight months. I was married in 1890 to Miss Alice Barry of Montreal and by this time I had a family of two children. My wife and family remained in Montreal while I was in Mexico. I left Monterrey because M. Guggenheim's Sons had secured Mr. Van Cleve as permanent metallurgist, my position being considered only temporary. Before leaving Monterrey, I paid a visit to Paul Johnson, at Aguas Calientes, where I saw the large

converters, the wonders of their day, that were used for converting the copper matte made from the Tepezala ore. These converters were 8 ft. across. They had been erected by Hiram W. Hixon. This was before the day of the electric traveling crane, so that the converters all had to be taken out on trucks to be emptied, and had to be taken apart in sections to be re-lined, as is still done at Mt. Lyell, Tasmania. Nowadays converters of this type are 20 ft. in diameter.

Mr. Mathewson, you must be impressed by the greater facilities now afforded to the metallurgist in the handling of his material.

Certainly. At the Mexican plant, for instance, much less than 50 tons of matte could be treated in a day by two stands of converters. At Anaconda, at the present time, six stands of converters are treating 1400 tons of matte per day.

Where did you go from Monterrey?

Back to Perth Amboy. Previous to taking charge there again I made a trip through the West, to Montana, taking in Great Falls, Butte, and Anaconda, then through Colorado back to Perth Amboy, inspecting the various plants on the way.

Do you recall any of your impressions?

The most curious thing that impressed me on that trip was not metallurgical. I had, a few months previously, bidden farewell to my old friend, August Raht, in Mexico, as he had started for Europe, intending to end his days there. I was surprised in going into the lobby of the McDermott House at Butte, to meet him and find that he was on his way to Australia. I bade him another farewell, and a few months later, I was at Pueblo and looking through the arch in the Union depot, I noticed a familiar back on the platform and went out and found my old friend again, on his return from Australia, heading for New York. Metallurgically, the thing that impressed me most was the size of the Anaconda smelter, which was considered a wonder, even in those early days. The plant, at that time, was handling over 3000 tons of ore daily, under the management of the late John S. Dougherty.

What is the present capacity of the Anaconda?

18,000 tons daily of copper ore, and 2000 tons of zinc ore.

You returned to Perth Amboy?

I returned to Perth Amboy and remained there as manager until September 1899, when the Messrs. Guggenheim asked me to take charge temporarily of a smelter at Playa Blanca, near Antofagasta, Chile, which they had leased from the Huanchaca company, the idea being that I start operations and turn the plant over to my successor in three months. Consequently I left my family at Perth Amboy and reached my destination at Antofagasta on the 13th of October 1899. I immediately put the furnaces in operation, under the charge of Ludwig Kloz, as metallurgist. But in a few months it was evident that I would have to remain longer, so the Guggenheims advised me that they would send my family down to Chile if I would remain a year. This I agreed to do, and my family all came down, with Mr. and Mrs. F. D. Aller, the present agent of the A. S. & R. Co. at Antofagasta, arriving early in 1900. I remained in charge as manager of the Playa Blanca plant until October 13, 1901, when I was recalled to New York.

Did this smelter at Playa Blanca have any interesting features?

It had many. There being no rain in that region, there were no buildings over the furnaces. In places there were sheds to keep off the sun; these were roofed with split bamboo. The furnaces presented a strange appearance. They were all exposed to the open air. The ores were refractory, and fluxes were extremely hard to obtain. The ores came from the Pulacayo mine in Bolivia, 15,000 ft. above sea-level, and were transported in narrow-gauge cars to the smelter, which was near sea-level. The water-jackets of the furnaces were supplied with salt water pumped from the sea. The water for drinking purposes used at the smelter colony was the overflow from a pipe-line, starting near Quillagua, 240 miles long, and this fluid, though clear, was anything but pure. It was contaminated with salt, nitre, borax, etc., and had to be distilled before use. In the town of Antofagasta they used sea-water largely for distilling. The ore, containing copper, lead, and silver, together with a little antimony and tin, and considerable sulphur, was made into adobes by hand, mixing it with lime burned on the premises; these adobes were dried by the sun, then piled up in racks and burned with

coke breeze, as ordinary mud-bricks are burned. After burning, they were conveyed directly to the blast-furnaces. The amount of impurities in the ore and the lack of fluxes made the slags extremely unsatisfactory to one accustomed to the metallurgy of Colorado, but the capitalists who were backing the enterprise did not see their way clear to advance any money to the poor miners of that country, who had no capital and could not work without some advance in cash. After using up a large quantity of slags rich in lead from Oruro, the discard from the ancient furnaces of the Spaniards, and no other lead being available, an attempt was made to use the lead concentrates from Broken Hill, Australia, one shipload of these being tried, but there not being sufficient profit in the arrangement, we discontinued this practice and substituted concentrate from Moyie, British Columbia.

Which mine?

The St. Eugene mine, in the Kootenay. This, as a business proposition, proved no better than the Broken Hill shipment, and on the advice of Willard S. Morse, representing M. Guggenheim's Sons, we gradually changed the furnaces from the use of lead to copper as a collector of precious metals. To this I objected on the ground that the copper ores available at Chuquicamata and vicinity all contained various chlorides, and would result in large losses of precious metals by volatilization. But Mr. Morse saw fit to insist, and the furnaces were changed as directed, with the result that the losses by volatilization proved so great that the operation became unprofitable. Meantime Mr. Morse returned to New York, the Guggenheims having merged with the American Smelting & Refining Co. Shortly afterward I was summoned to New York, and on my arrival there, in consultation with the firm, I advised that the operations of the smelter at Playa Blanca be discontinued, which was done, instructions being sent by cable. At the same time I was fired. This was a serious thing for me, as it appeared to me that all the metallurgical positions in my line as a lead metallurgist were in the hands of one company, and that company had no further use for me.

What did you do?

I took my family to Montreal, and immediately started on a still hunt for a job. I failed to secure one for six months, and was becoming desperate, when a good friend of mine, L. J. W. Jones, suggested that we enter into partnership and start a copper refinery on the Pacific Coast, possibly in British Columbia. I agreed with him that this was a business possibility, as he had a little money and could interest more capital, and I had a little of my own that I was willing to risk. I agreed to start for British Columbia and look into the situation. I had my grip packed, ready to leave, when I received a telegram from Frank Klepetko, asking me if I would come to Anaconda and look into the blast-furnace situation at the new Washoe smelter there, with a view to taking charge of the blast-furnaces if I liked the job.

That was in 1902?

Yes. In June 1902. I proceeded at once to Anaconda, met Mr. Klepetko, who took me down to the blast-furnace room. This was in such a sad condition that I thought there was plenty of work cut out for me if I liked to take charge of it. I could see no difficulty in the position, so I accepted his offer to act as blast-furnace superintendent. I found a peculiar condition of affairs. No less than eight different men had the authority, and used it, to change the charge of the blast-furnaces as they saw fit, the result being chaos. Of the five furnaces at that time supposed to be in blast, there were never three in operation at one time. I speedily rectified this, to the amazement of the furnace foremen, who found they were able to keep five furnaces in blast continually. Shortly after this, Mr. Klepetko accepted a position with James B. Haggin, to go to Cerro de Pasco and build a plant there, and F. I. Cairns was placed in charge of the Washoe smelter, as manager. I was asked to take charge of the reverberatory furnaces and roasters. These reverberatory furnaces were at that time the largest in the world. The hearths were 50 ft. in length and 19 ft. in width, and the furnaces were smelting on an average of 75 to 100 tons per day. These compare with the modern furnace of this type as follows: 140 ft. length of hearth, 25 ft. width, average smelting 650 tons per day.

How do the costs compare?

Costs at present in reverberatory-smelting practice are about one-third of what they were then. A few months later Mr. Cairns resigned to accept a position as manager of the Michigan Smelting Co. at Houghton, Michigan, which position he still holds, and I was placed in charge of the plant, remaining there until this month.

You are leaving Anaconda?

Yes. I have received a flattering offer from the British America Nickel Corporation to take the position of general manager of their properties in Canada, with headquarters in Toronto. This position I have accepted, and will assume my new duties October 15.

What mines does this company operate?

The company operates the Murray mine near Sudbury, Ontario, and it is proposed to build a smelter near the mine and a refinery for the electrolytic refining of the nickel matte near Niagara Falls, on the Canadian side.

Mr. Mathewson, you have had a good deal to do with the introduction of flotation in America, on a large scale. Could you give your opinion as to the scope of the process?

So far as my experience goes, the application of the process to sulphide copper ore is a wonderful success, and can be utilized in nearly every case that has come under my observation. Even where a part of the ore is oxidized, the sulphide portion can be recovered by flotation and a considerable part of the oxidized ore by the original gravity methods of concentration.

What do you think of the new method of sulphidizing the oxidized ore?

From experiments tried at Anaconda, indications are that the oxidized portion of the ore forms such a thin layer on the particles of gangue, that when the sulphidizing is completed and the artificial sulphide mineral submitted to flotation, the gangue floats with the sulphide and no commercial degree of concentration is reached. In my opinion the oxidized ore or the oxidized ›rtion of sulphide ore is best treated by some form of sulphuric id leaching.

'hat episode in your career pleased you most?

My recent appointment in Canada, which came to me wholly unsolicited.

You know that the technology of metallurgy is under great obligation to you and your staff at Anaconda for your hospitality, not only physically but mentally, extended to properly accredited visitors to your plant. I presume I may take it from you that you do not believe in secrecy in technology any more than our distinguished friend James Douglas.

I am of the opinion that the metallurgist with a secret process is like the ostrich that buries its head in the sand on the approach of danger. The metallurgist who is free to give out information is certain to receive information in equal or greater proportion. It has been my experience that on account of the policy pursued at Anaconda I or any member of my staff has been welcomed at the most secretive establishments and shown everything of interest.

Furthermore, is it not a fact that anybody going to work systematically, honorably or dishonorably, as the case may be, to get at any metallurgical method, can do so?

It is a fact. Secrets cannot be kept in a metallurgical works because so many are employed, and the cupidity of employees is always to be taken into account.

I was informed recently by a metallurgist who used to be at the old Pueblo plant that when the Guggenheim consolidation was made, the three smelters that were shut-down were the three secret plants, the Kansas City, the Philadelphia, and the Eilers.

One other secret one was not shut-down—the Globe. It is still running, but the staff is not so secretive as it was.

Now that you are leaving the Anaconda, I am frank to say that you ought to feel proud of the large number of metallurgists to whom that smelter, under your charge, has been a veritable post-graduate school of metallurgy.

It has always been my idea to give the young technical men under me a chance, and whenever an opportunity was afforded for one of them to better his condition by going to some other

plant, I have not hesitated to recommend a man suited for the particular position offered, no matter what place he occupied in our organization. I learned the value of this method in the early days of my experience at Pueblo, with the old Pueblo Smelting & Refining Co., under Mr. Geist. Many of the older metallurgists, some of whom are world-famous, were trained in that establishment, where I received my first knocks.

Who were at the Pueblo smelter?

H. H. Schlapp, of Broken Hill fame; Philip S. Morse, formerly manager of the Cockle Creek smelter in New South Wales; Tommy Ropp, as the Baron was known then; Wayne Darlington, now in Philadelphia; R. C. Canby, of flotation fame; W. W. Adams, now in California; S. D. Bridge, who made his name in Mexico; Ben Sadtler, afterward professor at Golden; O. J. Smith, of Reno, Nevada; and among the later crop, W. H. Howard of Salt Lake, E. H. Hamilton of Trail, B. C., W. J. Hamilton of Cerro de Pasco, Peru, and Forest Rutherford of Douglas, Arizona.

Do you regard metallurgy as a good career for the young men of today?

I do.

Do you think that metallurgists or managers of metallurgical establishments should have a financial interest in the company with which they are connected or in other mining or metallurgical enterprises?

I do.

You are doing some interesting work in the electrolytic reduction of zinc. Would you mind saying something about it? Particularly in regard to the future of this new branch of the art.

The work done at Anaconda in the electrolytic reduction of zinc has been most interesting. The general principles involved are the roasting of the ore, the solution of the zinc in sulphuric acid, the purifying of the solution, and then the electrolysis. Each step in the process must be watched most carefully, particularly the purification of the solution before electrolysis. The obtaining of a zinc sulphate solution from the ore is by no

means new to the art; but the details of the process in use at this plant have many novel features. Just at this time we are endeavoring to protect these patents, and consequently I am not at liberty to divulge further information. However, I will say that this new branch of the art promises great things for low-grade copper ores and low-grade lead-zinc ores (containing zinc above 12%). By the removal of the greater part of the zinc, the ore becomes readily amenable to treatment. Many mines have large reserves of ore of this character that heretofore have been unworkable and classed as waste; these reserves will now become available.

Would you agree in the opinion that electrolytic zinc is likely to drive retorted zinc out of the market?

No.

Did you receive the Gold Medal of the Institution of Mining and Metallurgy?

Yes, in 1911, and the receipt of this medal was the source of a great deal of pleasure to me.

Do you believe in young professional men writing technical papers?

I certainly believe in young professional men writing technical papers and contributing to the technical press, if they have anything to write about. A great many little things come up in practice that it is well to have recorded. It is a good thing for the young men to put their ideas into a crystalline shape and get into the habit of making notes systematically. I certainly agree with you; and in this connection, I think it would be well for all our mining schools to pay a little more attention to English, so that their graduates will be able to make readable reports and write short technical articles without any great effort. The manner in which facts are presented to a board of directors by the technical men in the employ of a company has a great effect upon the actions of the board in approving or disapproving the recommendations made.

Do you approve of the present system of settling ore-purchases on the quotations given in a technical journal? Would it be practicable to settle on the price obtained by the smelting-purchaser?

Of two evils, choose the less. I think the settlement on quotations given in a reliable technical journal is the less evil. We want to settle on the true market-value of the metals. The only way we can approach that is to get the figures of actual transactions. If the technical journal or its people has no dealings in the market, if it cares for its reputation, the results are not too bad. I do not think it practicable to settle on the price obtained by the smelting-purchaser because no smelting-purchaser would be willing to give out the actual figures pertaining to his sales of metals.

To what extent is the enlargement of copper furnaces likely to go?

The furnaces in most establishments are now as large as the ore-supply warrants. There is no limit to the length of a blast-furnace, but under existing conditions there is no advantage in the operation of furnaces over 75 ft. in length. The construction of the building to house very long furnaces is too expensive. In reverberatory practice the limit of economical size of furnace has not yet been reached, but the units are now about as large as it is safe to make them to ensure regular output. When the unit in reverberatory practice is too large, two units being down for repairs at the same time would cause serious reduction of output. On the other hand, in blast-furnace practice, any part of a furnace of the type used at Anaconda may be repaired while the rest of it continues operating normally. I believe that there will be no great enlargement of copper furnaces unless the supply of ore at some given point is enormously increased.

Referring to the saving of labor and the use of electric cranes, can you outline the extent to which such machinery has replaced manual labor?

Without electric cranes the big converter installations of the present day would be impracticable. In repair-shops and power-plants also, modern requirements demand such machinery. The builders of smelting and power machinery today always count on traveling cranes as part of the regular equipment; therefore they have no hesitation in designing parts weighing tons, whereas when only manual labor was used such heavy pieces were out of the question. A great change has come over

the laborer of today. He is accustomed to all kinds of labor-saving devices, and the man who makes his bread by the sweat—literally—of his brow around a smelting plant is a rare specimen.

In what direction lies the further development of copper metallurgy?

In the saving of values from the flue-dust and smoke, and the similar saving from the oxidized portion of tailing. I believe the time is not far distant when the application of electricity to the copper-smelting industry will be as important as it now is in copper refining. There is room for improvement in the reduction of copper in furnace-slags.

You have had a lot of experience in the abatement of smelter fume; do you consider that this difficulty has been overcome?

Each smelter-plant has its own particular smoke problem, and it will not be solved until there is a market for all the by-products that can be obtained from smoke. This means the utilization of the sulphur, either as elemental sulphur, as sulphur dioxide, sulphuric acid, or some other compound. In my opinion, if care be taken in the selection of a smelter site, so that the gases be discharged at a considerable height above the surrounding country, and settling apparatus, either electrical or mechanical, be installed to remove dust, no trouble should be experienced and no material damage done. The dilution of the gases with air and their discharge as high as practicable above surrounding lands is the best way to dispose of them until the time comes when all possible by-products can find a market. The addition of water for spraying the gases is inadvisable, in most cases, on account of the liability to pollute streams and water courses with the product.

You have helped many young professional men. Would you please give some advice based upon your experience in aiding them?

The remarks above referring to the working-man apply to professional men, also. I think it is well in dealing with young professional men to caution them not to be afraid to dirty their hands or clothes, but at the same time not to forget that they have spent a number of years of their lives in preparing for a

FREE TRADE IN KNOWLEDGE

*In this issue we publish an interview that serves to summarize the professional career of a supremely useful and public-spirited citizen. Few men are better known or have made more friends in an honorable way than Edward Payson Mathewson. The reasons for it appear in the interview, for no man can be catechized intelligently for a couple of hours without disclosing the mainsprings of his action. To us it seems that the metallurgist so long associated with the successful management of the Anaconda works is particularly the exponent of free trade in knowledge, of the open shop in experience, and of the helping hand to the young men of the profession. All of this argues a generosity of mind that is far more admirable than the giving of money or the endowment of libraries. In the 14 years he spent at Anaconda, Mr. Mathewson gave mental hospitality to hundreds of technologists from every civilized country in the world, showing willingness not only to allow properly accredited visitors to see the splendid establishment that he directed, but also to give them hints and suggestions that have proved fruitful in many smelters far from Montana. And he did this without allowing any trespass on the property rights of the company whose representative he was; at times reticence—even secrecy—may be required by the exigencies of business, and he knew when those times had arrived, and also when they expired, but it is remarkable that he was able to reconcile his duty to the company with his hospitality to visitors so that the latter forgot the small withholding in the large enlightenment. Another sagacious engineer of Canadian birth, Mr. James Douglas, the Bryce of mining, long ago exposed the stupidity of secrecy in the arts, and himself adopted the open-handed policy, believing it to be best for all concerned. We note Mr. Mathewson's reference to the fact that when the Guggenheims made their big consolidation of smelters, in 1899, it was the secret plants that were found so inefficient that they were put out of business. And we can say, what he naturally forebore from suggesting, that the establishments conspicuous for willingness to give information are exactly the ones that have prospered exceedingly, both in a technical and in a financial sense. Of course, a metallurgical secret is an absurdity, for

*Editorial in the 'Mining and Scientific Press' of December 9, 1916.

was wrong, and it has demonstrated also how a man of real capacity cannot be kept down by anybody. From lead smelting, Mr. Mathewson went to copper smelting, in which he achieved an equal specialization, and now, as if to round his career by attacking fresh problems, he takes charge of a big nickel enterprise. We can readily understand how gratifying it must be to him that he has been selected for work so interesting and so important as the British governmental exploitation of the nickel industry in Canada.

The labor question is one that every open-eyed man must face. Knowledge of humankind is at least as important as that of the metals. Our readers will appreciate the spirit animating Mr. Mathewson's remarks on the relation of employer to employee. He has placed his index finger on one of the fundamental weaknesses of the big corporation, namely, the dehumanizing of the administration. You can make machinery automatic —or very nearly so—but the complex play of the human relationship will slip a cog if there be no personal contact between the workman and the manager. How well Mr. Mathewson succeeded not only in his duties as an engineer, but also in his obligations as a free citizen in a civilized community is shown by the demonstration that was made when he left Anaconda on October 16. From the local musical organizations that he had encouraged, to the children for whom he had created playgrounds; from the technical men on his staff whose friendship he had won, to the people of the town whose goodwill he had gained; from all of these he obtained a regretful farewell and an enthusiastic godspeed that must have thrilled him to the very core of his being. It was a demonstration of which not only he and his family, but the profession whom he so worthily represents, may well be proud. Other men have been given gold cups and paintings, but there are sentiments that no organized testimonial can express. "For his welfare work in the Town; for his good work in the County and State; for the many things he has done to make this a pleasanter and better place to live, we owe him a debt of gratitude that we cannot repay, and we assure him his name will always be synonymous with good citizenship in this State." Thus said Mr. Laist in an eloquent speech at a farewell dinner. To have "a name synonymous with good citizenship" is worth more than much refined copper.

WILLET G. MILLER

AN INTERVIEW

Dr. Miller, you are a Canadian?

Yes, I was born in Norfolk county, Ontario.

Was your father interested in mining?

No, but he was interested in natural history—trees, flowers, and rocks—and he brought home the first collection of fossils that I had ever seen, from Manitoulin island in Lake Huron.

So you acquired some taste for geology?

I didn't pay much attention to mineralogy and geology until I went to the University. I had never seen compact rock in place anywhere in my native county.

What was your schooling?

I went to country schools, and then to the Port Rowan high-school, and stayed there until I had completed the first year's work in the University of Toronto. Before completing my course I stayed out one year, and had the experience of teaching in the high-school. That was owing to the fact that our local high-school was short of a teacher and my old master wanted me to put in some time with him; and I am glad I did, because it gave me an opportunity of planning the course and appreciating more what it meant.

In what year did you graduate at Toronto?

In 1890.

At the time of graduation, had you any plans for a career?

No; during my university course I specialized in chemistry and took mineralogy and geology as well. After graduation I was appointed Fellow in mineralogy and geology, and held the fellowship for three years, until 1893. The fellowship was intended to give one an opportunity to do post-graduate work, but

passed I was so interested in my duties that I stayed longer than I had intended.

You are still holding that position, are you not?

Yes.

Won't you proceed to describe the discovery of Cobalt, which, I believe, was the next important event in your life?

The Government of Ontario decided to build a railway from North Bay Junction, on the main line of the Canadian Pacific Railway, to Lake Temiskaming, to serve as an outlet for that agricultural region. During the construction of this railway, at a distance of 103 miles north of North Bay, some mineral deposits were discovered. There were no prospectors or miners in that region in those days.

Was there none in the crew working on the railway?

No, none. They were railroad men and nothing more. Late in the autumn of 1903 one of the men from that district brought a sample of ore to Toronto. He thought the sample was copper ore. It was the mineral niccolite, which resembles certain copper ores rather closely. When I saw the sample I knew that an interesting discovery had been made. I thought, of course, that it might indicate rich nickel deposits, as the well-known Sudbury area lies about 90 miles south-west of this locality, now known as Cobalt. As snow was likely to fall at any time in that latitude, it being late in the season—November—I hurried north, taking train to Mattawa, thence to the foot of Lake Temiskaming, and the steamer on to Haileybury, which is on the railway line, about five miles north of Cobalt. The steel had not been laid on the grade at that time, and the morning after our arrival I decided to go down to see the discovery. I walked along the grade, which was frozen, with a thin covering of snow, until I reached the place of discovery, which was on what came to be known as the La Rose mine.

Was there much ore showing in the railroad cutting, and what was the character of it?

No, it was on one side of the railroad, near the face of a cliff, at the bottom. A blacksmith employed on the right-of-way—named La Rose—had at one time worked in the phosphate de-

posits in Quebec and was more or less interested in minerals. He noticed this vein and when he had time he put a few shots in it. He evidently was after the 'copper', or niccolite, and was not taking much interest in the silver, for he blasted out some rich silver ore and threw it into the swamp.

Was there any native silver visible?

Yes, there was a lot of native silver; but the 'copper' was bright, and the silver was tarnished on the surface.

Did La Rose recognize the silver?

Apparently he knew it was silver, but he was not trying to save it, but was just blasting it out. Then there was a showing of silver in the bottom of a pit, the small opening that he had made. I got my pick under this and pried it up and got a piece about the size of my hand and about as thick. When I took that with me to Haileybury in the evening, the men there to whom I showed it began to get a little excited and decided to do some staking. Next day I went down to the discovery again, and I saw two or three other veins that had been found. One of these was a massive cobalt vein on what is now the Nipissing property. Another was on what afterward became known as the McKinley-Darragh, and the fourth was the most interesting vein discovered up to that time, or probably since. It was also on the Nipissing property, but the discoverer had not shown it to anyone. He was a Frenchman by the name of Hebert, who had been a professional strong man. The timber-cutters were at work on that area and Hebert was afraid that some of them might find his vein, so he took me to the place very cautiously. The vein was afterward called the Little Silver; it formed a fissure in the cliff, about 60 ft. high, and the face of the vein was weathered, leaving the silver exposed so that it was falling down the cliff. It was a real textbook vein.

The discoverers were not ordinary prospectors?

No; they were all employed in railway construction. La Rose was the blacksmith and Hebert was employed in some similar capacity, I don't know just what. He discovered some of these deposits by walking across to see a cousin, who, I think, was employed in cutting timber.

They had been in the employ of the railway construction company a few days before?

For some time; they were still employed. These discoveries were all within a few hundred yards of the railroad.

And all made within two or three days?

No; they had known of some of them for probably a month or two months, but hadn't paid much attention to them. I suppose they had never seen any ore before. La Rose had been working on phosphate, but I don't think he knew anything about metallic minerals.

Having made your inspection, what did you do?

I wrote to the Department, at Toronto, telling what I had seen.

Was that report published?

Yes. That letter was published with my subsequent report, I think. The result was that when I got out to the railway again the first thing I saw in the hotel was a large poster to the effect that the Government had withdrawn all the land for some distance along the railway, and for some distance on both sides—withdrawn it from prospecting and staking. A few months later the land was again thrown open to location.

And the locations were validated?

Yes; the locations on which the discoveries had been made were recognized from the beginning. The Government didn't try to take them away. It was difficult to get the public interested in these deposits. Not long before that we had had a mining boom, one of our periodical booms in Canada, in which many people had lost money. The public had lost interest in mineral deposits. I had a good exhibit of these cobalt-silver ores placed in the King Edward hotel at Toronto, for the benefit of the Canadian Mining Institute meeting in March 1904, but nobody took much interest in it. They were fine specimens, but that was about all! It took nearly eighteen months to arouse public interest.

Since then how much silver has the Cobalt district produced?

Over 292,000,000 ounces, besides cobalt, nickel, and arsenic.

Have you remained Provincial Geologist and continued your interest in the exploration of this Canadian hinterland? Did you have anything to do, officially, with Porcupine, in its early stage of development?

The result of the success of Cobalt was that we got many prospectors into the northern country and many men who were willing to give financial support to small syndicates of prospectors. Every year since then, almost every few months, some important discoveries have been made. Until the railway was completed north to Cochrane, the Porcupine country and other areas were rather inaccessible, requiring a roundabout canoe trip to get there. The important discoveries at Porcupine were made in 1908, but not much work was done until 1909, when we placed a party in the field, to map the area. We have had parties surveying and mapping the surrounding areas ever since, each year. Porcupine has become widely known and Kirkland Lake, a district farther south, is now becoming an important producer. Gold has been found in promising quantities over a wide extent of country. In so far as the geology is concerned, Cobalt has served as the key to a wide region. Any person having a good knowledge of the geology of Cobalt has little difficulty in mapping other areas in the region.

Do you consider that there is a likelihood of further important discoveries in that part of Canada?

Yes, Sir; I expect that many important discoveries will be made there.

I presume that some valuable outcrops may be covered by the lakes and swamps.

Yes, the most important vein at Cobalt, for instance, lay under a lake. The latest gold deposit developed in that northern country, namely, the Lake Shore mine, on Kirkland lake, is similarly situated. That, by the way, is an interesting mine. It is opened up to a depth of about 400 ft., and the ore from development work has given a recovery of over $24 per ton.

From gold in quartz?

Gold in quartz.

You have done a great deal of exploratory work in that part of Canada, and I should like to ask you to say something about the prospects generally, even outside Ontario, going so far as the Coppermine River district and Le Pas, in Manitoba. If you will be good enough to speak of the mining opportunities of this northern part of the continent I feel sure that what you say will be read with keen interest.

Canada has an area of about 3,750,000 square miles. About two-thirds of this area is occupied by pre-Cambrian rocks, and throughout these pre-Cambrian regions the conditions are much the same as they are in Northern Ontario, where we have already proved that they contain important silver, gold, nickel, and copper deposits. We have great hopes therefore that many more Sudburies, Cobalts, and Porcupines will be discovered in these pre-Cambrian rocks. During the last three or four years important discoveries have been made in the Provinces farther to the west, in Manitoba and Saskatchewan, for instance the Flin Flon and Mandy lodes. The Canadian government has a railway nearly completed to Port Nelson, on Hudson's bay. The road is graded and I think only about 90 miles of steel remains to be laid. As soon as this railway is completed it will be possible for a prospector to take a boat on Hudson's bay and land on either the west or the east coast, where there are vast areas of promising mineral territory. I look on the regions around Hudson's bay—the pre-Cambrian shield, as it is sometimes called—as the most important prospecting ground, or unprospected territory, that remains anywhere in the world. While much of this big stretch of land is unprospected, the Canadian Geological Survey has had parties through these regions at various times, and we know what the character of the rock is. For instance, we know that the rocks in the Coppermine River region are much like those in the great copper belt of Michigan and we know that these Coppermine River rocks extend pretty close to the western shore of Hudson's bay. That country is, in many ways, easier to prospect than Northern Ontario, because it has not such a growth of timber; it is more open. In some places, of course, it is low-lying, but elsewhere good exposures of rock are numerous. Then the east coast of Hudson's bay, which belongs to the

Province of Quebec, is promising, but has been prospected very little.

Why is that so?

Because this northern part of Quebec is difficult to reach by the St. Lawrence route. The rivers are rapid and difficult to navigate; but, as soon as we have some boats on Hudson's bay, the prospector will be able to get in and spend a good season there. The trouble with navigation there, of course, is in the straits; not in the bay itself. As you know, the Hudson Bay railway was built primarily to take grain from western Canada to Europe. I have always been in favor of building this road not because I was particularly interested in grain but because it seemed to me that such a vast region should easily support one railway. There are fisheries in Hudson's bay that have not been examined thoroughly, but the mineral possibilities are the more attractive to you and me.

You must have found your work as Provincial Geologist deeply interesting, having regard to the evident progress made by Ontario in mining.

Yes, our mineral industry has had a marvelous growth since 1902. Our annual output, for instance, at that time was valued at about $14,000,000, whereas for 1918 it is over $94.000.-000, according to the estimate of the Mines Department at Ottawa. The work, in addition to being interesting, has been pleasant, as I have always felt that I have had the friendship and support of the Ministers of Mines under whom I have served, notably the Hon. Frank Cochrane, who was Minister during the development of Cobalt. And our Deputy Minister of Mines, T. W. Gibson, has always been my good friend. I have had opportunities to visit other countries during the period I have been Provincial Geologist, as the official representative of the Mines Department. I have made trips to many parts of the United States, and to old Mexico, to Cuba, to Great Britain, France, Scandinavia, Australia, and the South Pacific. Naturally I was afforded unusual opportunities, for which I am grateful. Another thing that helped my work and made it pleasant was that I have had as my chief assistants former students of mine, from Queen's University, whom I knew thoroughly. Cyril W. Knight's work

is well known in connection with Cobalt and other areas; so also that of A. G. Burrows. E. T. Corkill, one of my former students, was for a number of years Chief Inspector of Mines in Ontario, and is now superintendent of mines for the International Nickel Company, at Copper Cliff. Mr. Corkill was with us during the interesting developments at Cobalt.

Were any unusual difficulties settled during your time of service as Provincial Geologist? For instance, if I recall correctly, there was some complication over the Gillies Timber Limit.

When the Cobalt deposits were discovered the mining laws of Ontario were rather crude. The regulations had been devised more for taking up iron lands; they were not adapted to precious metal deposits. The result was that we had to spend much time in preparing the Mines Act and other legislative enactments. The regulations that we finally adopted included those for the discovery of the precious metals. As we officials had made the discoveries on the shore of Cobalt lake, I advised the Government to withdraw the lake from location. It also withdrew Kerr lake and afterward sold Cobalt lake for $1,085,000, deriving a large revenue from the Crown Reserve mine on Kerr lake. The Gillies Timber Limit adjoined the Cobalt area immediately to the south. It was withdrawn from staking in order to protect the timber. Finally, the Government itself decided to work this 'Limit'. I was put in charge. I did not believe that much would be discovered, however, as I had mapped the area in detail; but as the Government had decided on the policy, I had to do the best I could. The Government was criticized a good deal by certain promoters, and prospectors kept constantly saying that if private individuals were working it a much greater success could be made of it. I quieted them to some extent by saying that I was "keeping a list of liars and lunatics who said they knew where there were rich veins on the Gillies Limit". It is remarkable how many supposedly reputable citizens at that time solemnly affirmed that they had seen valuable deposits on the Limit! After working it for some time, I advised that we give these private individuals and companies an opportunity to work it. We then surveyed part of the Limit and put the claims up for sale by tender, the result being that the Government received a

considerable sum of money; but no important discoveries have been made on it. I might add that, after the first sale, a discovery was made which created considerable excitement. Whereupon some of our newspapers said "I told you so" and "the Government did not handle this right", and so forth. I considered it quite a compliment to myself that when I immediately advised the Government to sell some more claims, it, despite the statements that were made in the press about the richness of the area, took my advice.

You must have taken part in the efforts made to obtain the metals needed for the War? For instance, I might ask you to say something about the public feeling in Canada toward the American ownership of the nickel deposits at Sudbury and the friendly efforts made to adjust that difficulty.

Of course, when the War started our people naturally became a little nervous, or sensitive, as regards nickel, because, although we produced over 80% of the world's output, we were not refining any in Canada, and the public feared that some of our Canadian nickel might be getting to Germany.

There was considerable agitation on the subject, especially after the submarine 'Deutschland' was reported to have come to this side of the Atlantic to take back a cargo of nickel?

Yes; nickel has been a disturbing subject at different times in the past; there has been a public demand for the erection of a refinery in Canada. The result of the agitation during the War was that the Ontario government decided to appoint a commission, known as the Royal Ontario Nickel Commission, which consisted of the late George T. Holloway, metallurgist, of London, England, McGregor Young, legal adviser, T. W. Gibson, Deputy Minister of Mines, and myself. We were given authority to investigate the nickel industry of the world thoroughly. We carried on work in Canada, the United States, and in Great Britain. Some of us went to France, Norway, Cuba, Australia, New Caledonia, and elsewhere. This work took a year and a half, our report being published in 1917. We now have a large new refining plant at Port Colborne. This belongs to our biggest nickel-mining company, the International Nickel Company. The Mond Nickel Co., an English corporation, which is also working

at Sudbury, refines its matte near Swansea, in Wales. The British-America Corporation, in which the British government is a large stockholder, is erecting a refinery near the city of Ottawa; so that within a comparatively short time Canada will not only be the principal miner of nickel, but a large refiner of the metal as well.

Does any of the matte go, as it did previously, to New Jersey?

Yes, the International Nickel Co. refines a large part of its matte in New Jersey, at the Orford works, near Bayonne.

How much do they refine in Canada?

Their plant in Canada started about the first of July 1918. The capacity of the plant at Port Colborne is 10,000 tons of nickel per annum, but in time the efficiency of the Port Colborne plant and double taxation may induce the company to do most of its refining in Canada. It is subject to taxation in both countries.

What are the prospects for the base-metal and precious-metal industries in Ontario at the present moment; that is, to what extent is the industry affected by the aftermath of war?

Our nickel output is not so large, but our gold output is expected to increase very much during the coming year. There has been a shortage of labor up to the present, but the mines are now getting all the men they need, I understand.

There is a confident feeling at Toronto, for example?

Yes, and I think this applies not only to Ontario, but to the more western Provinces. British Columbia is optimistic. They have a large territory there to develop and their output has grown rapidly of late years. Then, on the eastern seaboard we have an important iron and steel industry and vast coal deposits.

Dr. Miller, I understand, from my own limited acquaintance with conditions in Ontario and British Columbia, for instance, that many of the mines are owned by American capitalists. May I ask you to what extent the use of American capital in these Canadian mining regions is welcomed by the people of the Dominion?

It is always welcome. I might say that in Canada we have no restrictions on aliens from the Allied countries like you have in the United States. I understand that in the United States an alien cannot stake a claim. We have no such restrictions in Canada. Anybody but an enemy-alien can locate a claim, just the same as the native-born. We expect to get a great deal of capital from the United States, and we expect to have a large immigration from the United States, too, into the mining districts and into the agricultural districts of the West.

There is a duty on machinery, and I understand that there is even a duty on blueprints. Is there any prospect of a removal of some of these commercial barbed-wire entanglements?

I suppose that will depend not only on Canada, but on the United States. Of course, the feeling between the two countries could not be better than it is. We Canadians always feel at home in the United States, and we believe that citizens of the United States feel at home in Canada. We, in geology, for instance, in mining, chemistry, and in most of the other sciences, work very closely with our friends in the United States. For example, in pre-Cambrian geology I have been closely associated at times with C. R. Van Hise and C. K. Leith, and with other geologists in the United States. During my lifetime I have noted that the friendly feelings between Canadians and Americans have grown and increased constantly. Our peoples have become more friendly as the years have gone by, and, of course, the War has intensified this good feeling. We think that while we live under different flags we have the same aspirations, and nothing can interfere with these friendly relations in the future. Canada stands probably mid-way between the United States and Great Britain in many things.

Have you any signs of labor trouble in Ontario?

No; we do not think we shall have any trouble at all.

What is your labor chiefly?

It has been pretty well mixed in the past. Some of it is foreign, but a high percentage is English-speaking.

You have been a prominent member of the Canadian Mining Institute and of the American Institute of Mining Engineers. Would you say anything about the good work that either or both of them are doing?

I think it is recognized everywhere that the American Institute is doing wonderfully good work, not only for the industry, but also for the profession. Its growth during recent years has been wonderful. The Canadian Mining Institute is a much smaller organization, but it exercises a good influence in Canada. The governments of the Dominion and of the Provinces have always been willing to listen to recommendations made by the Canadian Mining Institute, and it has served a national purpose.

What are the prospects for an increase of production in nickel and of the discovery of new deposits, in your opinion, based on your recent investigation of the subject?

The quantity of ore proved in the Sudbury district has increased greatly during late years. When the Nickel Commission's report was published I estimated the proved ore—the ore blocked out—to be at least 75,000,000 tons. Since then there has been a considerable addition to this tonnage at Sudbury.

The other important source of ore is New Caledonia, I presume?

Yes, but there are no known deposits elsewhere in the world that can compete with Sudbury.

Are those of New Caledonia approaching exhaustion?

No; there is considerable ore there yet, but it occurs under conditions different from Sudbury. The New Caledonian ore occurs in lateritic deposits. Some of the deposits at Sudbury are probably unsurpassed in importance in the world among deposits of any kind, when you consider their size and the value of the ore. Of course, the War has encouraged the use of nickel-steel and other alloys. This means increased consumption of nickel in the future. Many people have used nickel-steel during the War that did not know anything about it before. Likewise the metal cobalt, for which there was little market, has come into prominence through the War. Cobalt is used with chromium and tungsten in the production of an alloy known as 'stellite', which is an important high-speed tool-steel. This use of stellite has increased the demand for cobalt very much.

life in a modest way, and he would have said little if the interviewer had not cross-examined him with friendly persistence. His father had the tastes of a naturalist and from him he inherited powers of observation, which, by academic training, developed into a faculty for scientific research. While a student at college he early became a teacher also, the learning and the teaching being complementary and thereby fulfilling the true meaning of the word education—the drawing out of the mental faculties. His has been a fortunate career; early appreciated by his countrymen, he received an appointment, that of Provincial Geologist, for which he was well equipped, and then, by good luck, he had the chance of taking part in a mineral development of scientific interest and industrial importance. Cobalt and Miller are names forever linked in honorable association. He appreciated the value of the discovery made in the course of cutting the grade for a railroad near Haileybury, in Ontario, and published a description of it almost immediately. The present writer, while editor of the 'Engineering & Mining Journal', had the pleasure of printing that first account of the discovery at Cobalt in the issue of December 10, 1903. Although a cautious man—a trait inherited from his Scottish ancestors—Dr. Miller did not allow his scientific judgment to be stifled; on the contrary, he came out boldly with the statement that "the ore is very rich, containing values in nickel, cobalt, silver, and arsenic; and a comparatively small vein could be worked at a handsome profit". In the 15 years since then Cobalt has produced 300 million ounces of silver. Dr. Miller has been amply justified in his forecast. He did more than that; he gave the miners in the Cobalt district a large measure of timely and practical geologic information; he did not wait until the mines were nearly worked out and then make a highly scientific autopsy or publish a delicately worded obituary; he distributed technical data while he was collecting them in his official capacity and thereby gave to the exploration of the ore deposits an intelligent direction that ensured success. During the Cobalt boom, with its orgy of mine promotion and stock speculation, he did not lose his head or endanger his integrity. While others became millionaires by following the advice he gave officially, he remained true to his duty. He might have enriched himself greatly, for he received many tempting offers to resign his appointment and accept both handsome retainers and pro-

to promote good feeling, by taking prompt steps to remove any minor points of disagreement arising more particularly from the barbed-wire entanglements of tariffs and custom laws. One thing is sure, any American engineer going to Ontario will find Dr. Miller, Mr. Thomas W. Gibson, Mr. Reginald W. Brock, and other men of their kind, only too glad to welcome them and to express their welcome by giving all the geologic information available. They may find the tall Doctor a bit reserved and non-commital at first, but when the crust of reserve has melted, they will find an inextinguishable warmth coming from a heart as big as his broad chest. Fertile in ideas, capable of wide generalizations, a good judge of human nature, shrewd but kindly, they will find a man neither easily deceived nor ever willing to deceive. His long legs are as much at home in the primeval bush as they are under the thwarts of a canoe; whether in the field or in the council-chamber, he is a born leader of men, and one whose leadership is accepted gladly. Alike as chief of an exploring party in the wilderness and as president of the Canadian Mining Institute in the city, he has won the confidence and affection of his fellows. Sentiment he has and the sense of humor, but most of all a willingness to help others. That characteristic has been evident throughout his life in Ontario, whether as student or teacher, geologist or official. He has trained a number of young men now honorably prominent in Canadian geology; he started them on careers of acknowledged usefulness. Honors have come to him, academic and professional, but no honor counts so greatly as the effectionate regard of the young men to whom he has given a helping hand. By his friends you shall judge him.

PHILIP N. MOORE

AN INTERVIEW

You are not a native of Missouri?

I was born in Indiana in 1849. My boyhood was spent partly in Ohio and partly in Missouri.

What was your father's occupation?

My father was one of the early civil engineers of the Mississippi Valley—a canal and railroad builder before my birth. The happening of my birth in Indiana was that he was there as engineer of a canal. He himself came—

He himself came from New England?

He was a Pennsylvanian. My mother was a New Englander, from Connecticut. Through her I am eight generations American. My ancestor, John North, came to this country in 1635. On my father's side the family was Irish, my great grandfather, Henry Moore, coming to this country in 1773.

What was your early education?

I was graduated in the classical course by Miami University, one of the oldest colleges of the Ohio Valley; my technical training followed at the School of Mines, Columbia University, where I studied under Newberry, Chandler, and Egleston, master-teachers of their day, and, I am proud to say, my friends in later years.

When did you graduate?

I was a special student at Columbia from 1870 to 1872.

Among the mining engineers, who were your classmates at Columbia?

Pierre de Peyster Ricketts, Arthur F. Wendt, Frank P. Jenney, and Peter T. Austen.

What made you take to mining engineering?

My father and two older brothers followed civil engineering and railroad building. Perhaps the desire for more individuality, the uncertain tenure of railroad positions at that time, or the romance of mining, then even more attractive than now, may have led to my choice.

How did you get your first job?

While a student at the School of Mines, Major T. B. Brooks, then in charge of the Michigan Geological Survey, in the iron regions, who was wintering in New York, was good enough to offer me a position.

Then you went to Michigan?

A season on the Michigan Survey under Major Brooks gave me a start in geological work which enabled me to secure a job under Raphael Pumpelly, then State Geologist of Missouri, which service was for only about a year by reason that one of the then, as even now, common incidents of State geological work —failure of appropriations—caused me to seek another job, which I found promptly under Professor N. S. Shaler, of Harvard, just appointed State Geologist of Kentucky. Under him, I worked nearly four years, when fortunately for me, from a financial standpoint, appropriations were again cut, and I sought wider fields, going to Leadville, Colorado, where I was one of the pioneers. In the interval I spent about six months in Europe.

In what year was that?

The spring of 1878.

Leadville must have been a lively place then?

It was an example of the ways of the frontiersman at that time—wild to him who sought such surroundings, but filled with the most attractive and intelligent set of young technical men with whom it has ever been my good fortune to foregather. This was in the early days of the technical engineer, who came into his own in a remarkable way. Never in all the years since have I dwelt with men of higher average intelligence and comradeship than the circle who made their start at Leadville.

Please mention some names.

A. R. Meyer, A. A. Blow, William Byrd Page, Fred Bruen, W. F. Patrick, Thomas L. Darby, Charles J. Moore, Max Boehmer, D. W. Brunton, Arthur D. Foote, Ferdinand Van Zandt, James B. Grant, W. S. Ward, Ralph Nichols, Henry E. Wood, and many others.

Did you meet Dr. Raymond at that time?

Dr. Raymond was not infrequently at Leadville, as expert witness in the important apex lawsuits, which dominated the courts of Colorado for years.

What was your first job there?

My first position was as smelter superintendent for a firm, for whom I built the second smelting plant at Leadville, subsequently known as the La Plata works.

Where did you get your previous experience for this job?

The task come to me unsolicited. It may be that it was a case where need, with possibly favorable impression of training or character, forbade rigorous insistence on experience. Smelting was very profitable. Charges ranged from $25 to $40 per ton. My employers fully understood the profit of hard driving. The already going plant was doing clean and slow work, smelting perhaps 15 tons of ore per day in a small stack. Using furnaces with about 40% larger area, we put through 40 tons per day—of course, not making as clean slags, but largely increasing profits. The waste was of small importance in view of greater tonnage.

Did you continue in charge of this smelter?

Less than two years, when I went 'on my own', leasing, prospecting, of course, and finding in the mining activity at that time sufficient examination work to keep me going in comfort.

Please tell me, Mr. Moore, what sort of fees did they pay at that time?

We used to get $25 per day, with an occasional $50 if the case were important. These were rare.

What were the conditions of living?

Somewhat crude, but not necessarily involving hardship. In the early weeks when we were establishing ourselves in California gulch, five of us, partners in a claim, shantied near where the Grant smelter was subsequently erected, doing our own cooking week about, until it developed that one of our party, a chemist, was an admirable cook—John H. Talbutt. Then it was agreed that he should do all the cooking, the remainder of us taking turns washing the dishes!

So you had a good time?

The place was full of hope and excitement. The atmosphere was optimistic, fear of failure was small; youth, courage, and hope took from poverty its sting. It mattered little were a young man 'broke', for he fully expected to strike it again the next day.

How long did you remain at Leadville?

Until early in 1882, when unexpectedly an offer came to me to open an iron property in Kentucky, which I had known and described years before when I was on the Geological Survey, with no expectation that ever the opportunity would come to me to share in its development. This offer was such that, although I had fully expected to end my days in Colorado, it could not be lightly refused.

How much money did you take with you from Leadville?

A few thousand dollars, enough to make me feel independent as against the near-by contingencies of life.

So you took charge of this iron property? Did the operations involve anything interesting in a technical way?

Nothing complicated. It was the simplest of quarrying operations, which was naturally one reason why it offered a chance for profit. It was known as the Slate Creek Iron Property. Upon it was built in 1791 the first blast-furnace west of the Alleghanies. I remained in personal charge of it for seven years, then my children—

When were you married?

In 1879, to Miss Mary Eva Perry, of Rockford, Illinois, who went with me as a bride to Leadville, under the great pity of her

friends, who thought that she was taking grave risks in going to such a lawless land, which anxiety might have been more intense had they known the experience of her first week, when she saw two policemen shot under her window. In 1889, my children reaching the school age, I removed to St. Louis—my old home, where I have dwelt since.

Why do you call it your old home?

My father moved here in 1859.

You established yourself in St. Louis in a consulting capacity?

In a consulting capacity, retaining charge of the iron enterprise of which I was the chief executive and a part owner. The proposition which carried me from Colorado covered not only what for that time was liberal compensation, but a year's option to take one-fourth interest in the enterprise, which I was able to do.

What was your next departure?

I retained charge of this enterprise until it was worked out, meantime with friends acquiring a large brown-iron-ore property in Alabama, which we retained for a number of years, but finally sold to one of the larger Birmingham consolidations. I was president of this company for 18 years.

You have had a good deal of experience in the mining of iron ores, which is unusual among our Western men.

Our operation in Alabama originally started with the charcoal blast-furnace. This was abandoned with the exhaustion of timber, ending in commercial mining of ore for various furnaces in Alabama and Tennessee. We operated a very large brown-ore mine known as the Baker Hill. It carried an ore lens about 100 ft. thick and 300 ft. long. When the overburden was light, we mined this cheaply. Evidence of this is that in the hard times of the '90s we sold iron ore as low as 80 cents per ton of 2240 lb., and more than covered expenses, our actual mining cost including overhead at that time being about 60 cents per ton. Of course, this did not pay for depletion, but it kept the operation

alive in hard times. The same ore during the War would bring approximately $3.50 per ton.

That brings us to what year?

This property was sold in 1908. During all this time I was practising as work offered, ranging, with the usual fate of the consulting engineer, over most of the mining States and Territories, into Canada and Mexico, traveling for some years around fifty thousand miles per annum.

Can you mention any of your operations that proved important or otherwise interesting?

Probably on the whole the most interesting enterprise with which I have been connected, and which in fact I organized and assembled, was the Conrey Placer Mining Company, of Montana.

How did you get into that?

In 1896, while employed by Bigelow & Bixby, of Boston, to examine a placer in Idaho, on the request of the promoter, who was with me, I stopped off at Alder Gulch, Montana, to see a proposition on which he then had an option. This property was known as the German Bar tract. It covered about 1½ miles of the gulch. The operation contemplated was the re-working of the old tailing by machinery. It developed that this tract was under option to another party, whom I met on the ground. The incident was pleasant to neither party, but I recognized possibilities, which led to the request that should the then holder of the option fail to close, it should be offered to my clients. At the same time, I was shown the Conrey ranch at the mouth of Alder Gulch, by John C. Sloss, an old Montana miner, who stated that he had talked with the owner and could secure an option for a year at a reasonable price—$30,000. While in Idaho, the option on the German Bar property lapsed and was promptly taken up by my clients. We re-visited the property in October and closed for its purchase, paying one-quarter down, the rest in three equal payments. If I remember correctly, the price was $100,000. At the same time prospecting work was started upon the Conrey ranch, on which we developed more than 200 acres of payable dredging ground. It was acquired by my clients in the following year.

Was Professor Shaler one of your clients?

Professor Shaler was associated with the gentlemen whom I have mentioned. He enthusiastically accepted, as he had done through nearly 30 years of our close business association, my judgment regarding this property. He visited it the following summer, after it had been purchased.

That was in 1897?

Yes.

When did Hennen Jennings become connected with the enterprise?

Nine years later—in 1906, when he and his associates purchased my interest.

Did you have any interesting technical experience in connection with this enterprise?

The first attempt to work the property was by means of an excavating cable-way; this was an ingenious device, developed for us by the Lidgerwood company; it functioned profitably on relatively high-grade gravel in the upper part of the German Bar tract. The first year's work, if I remember the figures correctly, upon this tract yielded 37c. per cubic yard at a cost of about 24c. This was free ground which had been worked over by the old-timers by the 'shovel in and shovel out' method, under which each miner was allowed but 100 ft. of the gulch for his claim and had to deliver the water to his neighbor below, free of sand. Operating cost of the cable-way was prohibitive for the ground on the Conrey ranch. We therefore came to dredging, which, at that time, was being carried on in Grasshopper gulch, some 40 miles distant, with small double-lift dredges.

Was Ben. S. Revett there then?

Previous to that time he had been, but not actively at the time of which we are speaking. In the dredging industry we experienced the usual history of early developers; we built machinery and tore it to pieces, re-building stronger, and repeating the operation until at last machinery was evolved to meet our requirements.

Can you give me comparative figures for the capacity of the dredge and cost of operation at the beginning and at the end of the period of growth?

At the beginning of operations single dredges used 3½ to 5-ft. buckets, steam-driven, involving costs of from 12 to 13c. per yard. The property is now almost exhausted, but one dredge remains, electrically driven, with 16-ft. buckets, handling nearly 400,000 yd. per month. It has shown a cost, for an entire year, after full charge for upkeep, of 3.16c. per cubic yard.

Did you make any innovations in dredging practice?

We were the first to prove that dredging was practicable throughout the Montana winter, incidental to which we introduced the plan of flooding the surface to keep the loam from freezing, in which also I think we were pioneers.

What was the capacity of the 5-ft. dredge?

About 40,000 cu. yd. per month.

One-tenth of the present rate?

Yes. The Conrey property in its earlier days, until the time came for excavating the fringes of the main deposit, was remarkable in its uniform yield. It was at times almost possible to predict a clean-up from the number of hours operation of the dredge.

This enterprise, taken altogether, proved highly profitable?

It has been very successful.

Roughly, how much, a million or two million dollars?

I have not the figures to date. Judging from the output for the time when it was under my close knowledge, I estimate that the property has yielded gross around seven million dollars.

Did Harvard College participate in these profits?

Colonel Gordon McKay, a retired mechanical engineer, of the older generation, a client of mine for 30 years or more, came into the Conrey property after my original employers reached their financial limit. He had been many years retired and was but casually interested in life. The control of the property that, dur-

ing all the mechanical difficulties of operation, always responded to work by production, revived his interest in his old profession. He died before the property had got to its big results, but with absolute confidence in its outcome.

What was McKay's relation to Harvard?

Colonel McKay left his estate to trustees, to be used for the benefit of Harvard College. This included his interest in the Conrey Placer Mining Company.

You were engaged as engineer in other placer-mining operations in the West?

Only on examination work.

You were much in Mexico?

For several years, until the revolution unseated Diaz, a large share of my work lay in Mexico.

Did you have anything to do with lead mining in Missouri?

I have had no executive responsibility for any of the large operations. Some years ago, C. P. Perin, of New York, and I examined one of the large properties as a preliminary to some financing. We recommended the loan. For a time thereafter I represented the bondholders on the board of directors, and as such had knowledge in detail of what was being done. This was the Doe Run Lead Company of south-east Missouri.

I remember, Mr. Moore, when I was at Joplin, in 1917, I heard of your successful zinc operation in the Miami district. Will you state how you got into that?

This property consisted of 120 acres of Indian leases, which were brought to the attention of some of my friends and myself, with the result that it was undertaken and developed to a producing property, but was sold within less than two years to wealthy oil-operators of Tulsa, Oklahoma.

This was the Admiralty mine, was it not?

This was the mine of the Admiralty Zinc Company. It is still operating, one of the steady and largest producers in the district.

You obtained the ground on leases from the Indian owners?

On the contrary, the leases were taken from sub-lessees.

On what royalty?

Royalties varied from 15% to 20%.

Were the Indians greatly enriched by the transaction?

At the time we sold we were paying about $5000 per month to one Indian.

Did you have anything more to do with that interesting district?

Not since then.

What were you able to do during the War?

If I was of any national value during the War, it was because of my work to prevent duplication of effort on the part of various committees and organizations; and in the formation of what was then known as the War Minerals Committee.

At that time you were President of the Institute, were you not?

I was elected President of the American Institute of Mining Engineers less than sixty days before the declaration of war. Immediately following, enthusiastic and patriotic engineers urged that I place the Institute at the command of the Government. Various technical committees had been organized. My service consisted in helping to co-ordinate these committees, and preventing special investigations of mineral resources by a certain very potent Board, by showing to them that the Government bureaus were already in possession of a vast body of information which could not be duplicated in reasonable time by new investigators. I insisted that the committees, wherever possible, should work through the existing government agencies: the Geological Survey and the Bureau of Mines.

You have not mentioned the most direct service and the one that entailed the greatest amount of your time and patience, namely, the War Minerals Relief Commission; when did you begin that work?

I first learned the intention of Secretary Lane to organize such a commission by the receipt, in March 1919, of a telegram from him, asking if I would accept appointment upon it.

Your colleagues, as I remember, were Senator Shafroth and—?

My colleagues were Ex-Senator Shafroth, of Colorado, and Ex-Representative Foster, of Illinois. In a few months, Dr. Foster's death left a vacancy which was filled by the appointment of a mining engineer, Mr. Horace Pomeroy, of San Francisco.

How long was that commission in existence?

Although Secretary Lane stated his expectation at the time of appointment that the task would be accomplished within a year, it actually required more than two.

As you know, there has been criticism of the rulings of the Commission, and some of it may seem to you to have been unfair. You must now be in a position to look back upon your work with a good deal of satisfaction?

Possibly enough time has not yet elapsed to enable me to take a detached view of the work, and its critics, but under my present light, I cannot see any line of decision, or method of treatment in the cases, which should be materially modified.

Won't you say something about the difficulties that you encountered?

The criticism came from interested and disappointed parties. Further, the rulings which resulted in the elimination of the largest number of claims were forced by legal opinions of the Solicitor of the Interior Department and the Attorney General of the United States, which were mandates to the Commission, and necessarily to be followed. The task was one of great difficulty by reason that there were no contracts formal or informal. The duty of the Commission was to determine what "net losses" had been incurred by claimants "in consequence of" request or demand of certain named governmental agencies. Necessarily, if a man, previous to the entry of the United States in the War, had been engaged in the industry which resulted in loss, the Government could not have been responsible, unless he could show either that he had increased loss by additional investment through Government request, or that he would have ceased but for it.

Then it became a question of determining the amount of stimulation for which the Government was responsible?

Yes. It was readily seen that a matter of this kind was one of great difficulty; especially in view of the naturally insistent demands of claimants, who, once possessed by the belief that the Government is their debtor, are apt to lose the sense of proportion.

You have reason to be proud of having been President of the Institute. You probably have definite ideas as to the functions that the Institute can best perform in behalf of the profession?

Naturally, I have given thought to such matters, some of the conclusions of which were expressed in my report at the time I passed from office. The problems are difficult. They lie between extreme centralization of control, with fair efficiency, and the opposite of decentralization, with loss of continuity of action. The gravest problem is to secure a voice in the detailed policies of the Institute for the men in the hills who do the real work of the profession. My theory of it is that ultimately the directors must be chosen by districts and some method evolved by which their attendance, at a reasonable proportion of the meetings of the board, at least, can be secured. The next in importance is to get the membership to realize that they have obligations to the organization. To my knowledge it is the earnest desire of the men in the East, who now necessarily make the decisions of the Institute, that the West shall have and exercise a potent voice. To that end, Western directors are always elected, but instances have arisen where a man would remain a member of the board for three years without attending a single meeting. At the present time there are five directors from the West, only one of whom has attended a meeting since February. In 1919, of three Western directors, two attended one meeting each. In 1920, of four Western directors, one man attended one meeting, and in the first half of 1921, with five directors, no man has attended any meeting.

Mr. Moore, what do you mean by the West? To us who live in San Francisco, the West probably begins nearer the Pacific than it does with you; do you mean west of the Mississippi River?

West of the 100th meridian.

Which is—?

In or west of the Rocky Mountains.

But, surely, the gentlemen in New York consider St. Louis west, do they not?

That is true of many, and in our own minds, we hold with them. I am thinking as I speak of the Mountain and Pacific Coast membership.

The problems of the national engineering societies are difficult for the reason that none of them are able to carry their necessary expenses from the dues and initiation fees paid by the members. There has grown up, however, a constant small revenue from the sales of publications, which have made up the deficits.

To what extent is the financial stringency of the Institute due to the exuberance of its publication activities?

I am not prepared to accept the word "exuberance".

Go ahead.

There is always to be heard the voice of the man who wants few publications. Generally, he is mature and has acquired a permanent set as well as a specialty. A young man, still believing that his future may lie in any one of many directions, is apt to want everything he can get. These young fellows accumulate documents, reports, and papers after the fashion of the young wife in the Kentucky mountains. Years ago, when examining a coal tract in Breathitt county, I was directed to the home of a man called Old Flint Ridge George Miller, who would not only take care of, but would vouch for, me—sometimes important in that country. In the home—a two-room cabin—were the old man and his wife, my assistant and myself, and upstairs, the youngest son with his newly won bride. They were building a cabin over the hill. The old man, commenting on the new daughter-in-law, said: "That thar gal is just like one of these yar mountain rats—every time she goes into that house she carries something". These young engineers often carry information to their files more effectively than to their intelligence, until years teach them the improbability of ultimate omniscience, and they reject, initially, material which they know is likely to be of small use.

You anticipate the revival of mining, do you not?

I have no idea as to time, but the curve of mining, like

other business, shows recessions and subsequent peaks. One of the advantages of years is a realization that metal production will not cease. I remember in the 'eighties traveling with an old friend who had long been in copper mining. The metal at that time was worth about 9 cents per pound. His depression was great, and he expressed the desire to get out of industry, fully believing that it would never be any better. He did withdraw from his then active operations, but since then he has been almost constantly interested in other copper enterprises.

If we remember that, roundly speaking, the metal production of the United States doubles every ten years, producing thereby practically as much as in the whole previous period, you will find it difficult to doubt the return of large production. I believe in the increasing value of deposits of all mineral ores. The public does not realize that in mining we draw on a bank account where no deposits are made and that the easily accessible deposits are becoming steadily less. Therefore, the value of good mineral deposits is bound ultimately to come to the higher level. To develop them will create continually increasing demand for engineering skill, but it is more than probable that the engineers who so serve will be spokes in the wheels of great organizations rather than independent producers.

Have you any pronounced ideas on mining education?

I have a growing realization that after all, the greatest ability lies in the power to persuade and direct one's fellow-men. Mere technical knowledge can never give this. Possibly it is entirely a matter of native power, which no education can impart. I believe, however, in a broad grounding in the fundamentals of science, history, and language, rather than in the attempt to teach finished details. The young man leaving the mining school is largely a creature of chance, tossed by the waves of opportunity into the channel of activity where he finds sustenance. If he be well grounded in the great fundamentals of science, with the ability to write and speak the language, he can acquire the details of the calling into which he has come, far better than he can acquire the fundamentals which may be missing, should he have prepared for another line of industry than that in which he is cast.

A WAR COMMISSIONER

*In this issue we publish an interview with one of the honored veterans of the profession, Mr. Philip N. Moore. That he is in truth a veteran we were hardly aware until he responded frankly to our systematic curiosity, for he is one of the men fortunate enough to retain the spirit of youth long after the time for jumping hurdles or even playing tennis has passed. Youthfulness of spirit joined with maturity of mind is a happy combination, and he seems to have had it from the first. The interview shows how at an early age he went to Leadville, when that famous silver-mining centre was in the heyday of its first development. As one reads of the early days in the West, when the frontier of civilization was on the horizon, one is tempted to ask whether it were not better to have been born sooner so as to participate in the real romance of mining adventure. Later time has brought its compensations, but one thing the younger men may envy, and that is the companionship of such alert minds and interesting characters as were at Leadville, for example, in the late 'seventies and early 'eighties. Nowadays most engineers reside in big cities and make an occasional short visit to a mining district; in former times, owing to the difficulty of travel, they lived in the mining camp, which was fitly named because many lived in tents or shanties, and the community was nomadic. Mr. Moore knows how to express himself; his replies to our questions convey the atmosphere of hope and elation in which he and his comrades lived. He indicates also the vicissitudes of an engineer's life in those days; how the technican had to be ready to do many things and to adapt himself to tasks for which perhaps he had received no direct preparation, but for which he had always, as Mr. Moore had, the background of a thorough technical training and the alert intelligence that came partly by inheritance from quick-witted progenitors and partly from the breezy initiative of what was then the West. The basis of his financial success was the money he made as manager and part owner of two iron-ore enterprises, both of which, thanks largely to his own skilful management, proved highly productive and profitable. This prepared the way for a successful start as a consulting engineer, with head-

*Editorial in the 'Mining and Scientific Press' of January 14, 1922.

quarters at St. Louis, from which city he traveled far and wide as his engagements called him. The story of the Conrey placer will interest Harvard graduates especially, because it involves several notable men, more particularly the much-beloved Professor Shaler. Another successful operation, in later days, was Mr. Moore's venture in zinc mining, on the Indian lands of the Miami district, in Oklahoma. That was during the War. He sold out handsomely just in time to divert his energies to the national service, to which he has devoted himself since then. His ability to perform a patriotic duty was enhanced by the fact that in 1917 his high standing in the profession was recognized by his election to the presidency of the American Institute of Mining Engineers. That gave him official status as the standard-bearer of the profession. In the rush to aid the Government there was excessive haste to organize committees, which became so numerous that they interfered with each other. Mr. Moore was enabled to prevent duplication and waste of effort by co-ordinating the industrial investigations necessitated by the War. Later he was instrumental in arranging for the representation of engineers, at Washington, especially charged with the duty of pushing the campaign for a National Department of Public Works. This he did in 1918 as a member of Engineering Council, the president of which was Mr. J. Parke Channing, who backed Mr. Moore not only by his voice but by subscribing the money needed to meet the expenses of representation at the national capital. Next came a more arduous task. Mr. Moore was one of the three members of the War Minerals Relief Commission, appointed in 1919 to apportion pecuniary compensation to those who produced sundry war minerals in response to the call of the Government. It is only fair to say that Mr. Moore was the strong man of the Commission and that he did his work under a keen sense of duty and with a sincere desire to do the right thing. He was criticized, of course; and, among others, by ourselves. We took exception to his attempt to prove self-interested motives, as against purely patriotic motives, on the part of claimants, holding that this line of cross-examination was mistaken. That was the only criticism that we made, and our disagreement with Mr. Moore on this point persists to this day, but it has not impaired the goodwill that subsists between us. He keeps his friends, as Stevenson said,

"without capitulation". He is not of the small-gauge men that break a friendship on account of fair criticism or reasonable difference of opinion; on the contrary, he conforms to the definition of a friend that we think the best: a man whom you know well and still like. Per contra an acquaintance is a person whom you know slightly and therefore like. From personal knowledge, we believe Mr. Moore stands the test we have suggested. He has achieved the two things that men value most: the winning of friends and the realization of a desire to be effective. To this achievement his personal qualities have contributed, for he has a penetrating mind and is a good judge of men; he has social adaptability and an engaging manner; his ability to speak in public is suggested by the style of his diction when interviewed; he has an excellent memory, upon which he can draw confidently for apt quotation, including poetry. Neither the sense of humor nor the wit of the dialectician is wanting. Nevertheless, he does not bargain with the truth. He has been a happy man in most things that men value, and most of all in his marriage, for Mrs. Moore is distinguished among American women and a partner in matters of the mind as in domestic affairs; she is now serving her third term as president of the National Council of Women of the United States. Mr. Moore himself is fond of work and does not shy at difficulties; he gives ungrudgingly to the public service; for 12 years he has been on the board of directors of the Missouri State Geological Survey, giving gratuitously not only his time but his enthusiasm for such scientific labors. He took the lead in organizing the St. Louis Section of the Institute, and when president of the Institute he did much to stimulate the vigor and usefulness of similar Sections in other parts of the country. He has the instinct of leadership and the gift of inspiring loyalty. He takes a personal interest in the younger engineers and has helped many of them in making a good start. Of all the rewards that have come to him we envy him most the gratitude of a number of capable and useful men to whom he has given a start, freely and sympathetically, and a helping hand afterward. They and their achievements are a part of his own reputation; they bless him now and they will bless him in the years to come.

SEELEY W. MUDD

AN INTERVIEW

You were born in the West, Mr. Mudd?

I was born at Kirkwood, a suburb of St. Louis, in Missouri, on August 16, 1861.

You come of English stock?

Of a complex mixture of English, Dutch, Polish, French, Irish, and Scotch. From my mother's side I can claim French Huguenot blood. My paternal ancestors originally came from Poland. On account of religious persecutions they went to England, where they remained for three centuries. When Lord Baltimore came to this country and founded the settlement in Maryland, two brothers of the name of Mudd were in the party, one or both acting in some secretarial capacity. Our family is descended from one of these brothers. A portion of an original grant of land near Baltimore from Lord Baltimore to one of the brothers is now held by my cousins.

You were educated at St. Louis?

At the Washington University of St. Louis, receiving the degree of Engineer of Mines in the year 1883.

What notable members of the profession were at this college in your time?

William B. Potter was at the head of the mining school. Arthur Thacher and George C. Stone were assisting Professor Potter. Pope Yeatman, Joseph P. Gazzam, and Edmund B. Kirby were my classmates.

Looking back on this period of preparation, do you feel that the instruction you obtained at that time was suited to the making of your career?

The course we had at the Washington University was quite similar to and of quite as high a grade as that given in other

schools at that period. I owe much to the opportunities I enjoyed there. As compared with the courses now given at the better mining schools it seems, of course, rather crude and decidedly incomplete.

What was your first job after graduating?

Immediately after graduation a half-dozen of us went to Ste. Genevieve, in Missouri, where there was a small copper mining and smelting enterprise under the superintendency of Frank Nicolson. Primarily we learned what we could, but all of us took shifts at the smelter; for some weeks we dumped slag-pots, fired furnaces, and helped generally around the plant. The shaft-furnace made a matte of 20 to 30% copper. This was recharged into a reverberatory furnace, to be brought up to a black copper through the series of tedious operations then in vogue. The black copper was charged into a furnace like those in the Lake Superior region, and then slowly refined by poling. Occasionally we stayed on shift for 24 hours at a time watching these tedious operations.

You did not stay there long?

No. After leaving there I obtained a job as assayer under Samuel A. Barron, then superintendent for the St. Louis Smelting & Refining Co., at a lead-smelting plant five miles out of St. Louis. At this plant they were just completing furnaces for reverberatory copper-smelting, and there was in process of erection an electrolytic refining plant, one of the first in the country.

In what year was that?

1883.

What pay did you receive?

$60 per month as assayer. My experience at Ste. Genevieve proved valuable, for shortly after the copper plant was started I was able to help with the furnace work and without much delay was put in charge of the copper department of the smelter. From that time forward, while continuing to act as assayer, I was in direct charge of the reverberatory smelting and electrolytic refining under Mr. Barron.

How much was your pay raised on account of performing these additional duties?

At the end of two years I was receiving $125 a month.

You evidently made a good start and attained a position of responsibility in a short time. You must have enjoyed your work?

I did enjoy it. It was no eight-hour day; all the time was full of interest as well as work. Samuel A. Barron, who was then superintendent of the plant, has retired and is living now at Los Angeles. George D. Barron, his brother, was book-keeper at the plant and left for Mexico shortly before I went to Leadville. He is now living near New York City and is one of the directors of the American Institute of Mining and Metallurgical Engineers.

How long were you at this smelter?

About two years and a half.

Why did you leave?

Because of an opening at Leadville, Colorado. In December 1885, I went to Leadville with Charles M. Donaldson, who had just been made manager of the Small Hopes mine, then in bonanza and one of the great mines of the district. My first duties were those of ore-sampler. All the ore from the mine was shipped to the local smelters or to those at Pueblo and Denver. The sampling was done in Leadville. There I got into numerous discussions as to the accuracy of the sampling, which was rotten. Improvements were gradually introduced. The Small Hopes was then in rich ore, in places almost massive silver chloride. Some of the most beautiful specimens I ever saw came from this property at a depth of 200 feet. These were tempting to the ore-thieves, and after a few months investigation it became clear that there was a well organized system of stealing. A number of the thieves were sent to the penitentiary and many more were driven out of the district.

You must have become manager of the mine soon, because I remember meeting you at the Small Hopes and being taken underground by you, in September or October of 1886, I think.

I remember very pleasantly our numerous meetings in Colorado. I may have been temporarily in charge at the date you fix, but I was not made manager of the property until the summer of 1887. Mr. Donaldson left to take charge of the Eureka & Excelsior property near Baker City, Oregon. The financial group that controlled the Small Hopes, namely, R. C. Kerens, James G. Blaine, Senator Elkins, Senator P. B. Plumb, H. B. Denman, and Major Hood, most of whom were then active in politics, had purchased the Eureka & Excelsior; and Mr. Donaldson had received a letter saying that they wanted him to take charge of one mine and me to take charge of the other. Being a very young man, I told Mr. Donaldson that I would be glad to accept either one, and he chose to go to Oregon.

Well, Mr. Mudd, you were extremely fortunate, for I happen to know the career of the 'E. & E.', as it is called in Oregon, as well as of the Small Hopes. How long were you manager of the latter?

I was on the payroll of the Small Hopes for 25 years.

When did the mine cease operations?

The bonanza ore was exhausted in 1887. Thereafter more complete exploration followed and the old stopes were worked over and over as decreasing smelting charges and improved economic conditions generally made possible the shipment of low-grade ores. To bolster up the declining profits of the company, leases on other territory were secured, and for many years the exploitation of leased ground was by far the more important part of our work. The Small Hopes Consolidated Mining Company sold its property in 1912 to a local syndicate, which operated it for a time and then sold it to the Empire Zinc Company.

Then the Small Hopes became more important as a producer of zinc than of silver?

The production of zinc has not been large.

How much lead and silver did the Small Hopes produce?

It was not a large producer of lead, most of the ore being 'dry'. The net profits of the company were between three and four million dollars. The gross yield from the smelters was be-

tween six and seven million dollars. During the bonanza period the total cost at the mine, exclusive of smelting, amounted to less than 15% of the amount received in settlement with the smelter.

What was the grade of ore during the bonanza period?

From 60 to 80 oz. per ton, as an average.

How would you compare the type of miner you employed at Leadville 35 years ago with those that you find now, for instance, at Oatman or even at Leadville?

When I went to Leadville, over three-quarters of the miners at the Small Hopes were Cornish, with mining in their blood for generations. No better miners have ever existed. Gradually the percentage of the Cornishmen decreased and we got an increasing number of Americans and Irishmen. They. too were excellent men after they had obtained the requisite experience. In Leadville most of the mining is done now by Austrians and Scandinavians, who usually are hard workers, but are not the equals of their predecessors in skill. I got so I could understand the Cornishmen fairly well, but with the Austrians and Finns the difficulty of language was insurmountable at times.

Will you say something about what is called the labor question?

The specific demands and immediate aims of labor today differ from those of the past, but human nature changes slowly, and the present feelings of the laborer and capitalist are quite similar to those of the days gone by. Daniel Webster in 1833 described with remarkable accuracy the labor agitator and the feeling of unrest as they exist today. Labor has become dominant during recent years; it has grown so arrogant and unreasonable that the sympathy of the mass of the people is swinging away from the unions. Great power is dangerous; few have self-control, sanity, and tolerance enough to use it discreetly and well. Capital is apparently more sympathetic and just than ever before. partly at least because of necessity; if the agitator who is disloyal to his country and intolerant of all difference of opinion can be deprived of his influence, a speedy readjustment to a reasonable degree of harmony should take place, notwithstanding the slackening industrial activity that is ahead of us. Intolerance of different races, of the followers of various religions, of the am-

bitions of different peoples and factions have caused most of the wars in history. Intelligent and sympathetic toleration of the viewpoint of the other side would soon draw labor and capital together, and would bring to our people a wonderful period of happiness and prosperity.

With what other properties were you connected at Leadville?

I was manager of the Leadville Consolidated Mining Co. and of the Boreel Mining Company for many years, and for a few years I was manager of the Ibex Mining Company, controlled by John F. Campion, A. V. Hunter, George F. Trimble, Eben E. Smith, and others. The Ibex mine was not only very rich, having produced more than any other Leadville property, but the ore occurrence was unusual and extremely interesting. I started leasing in a small way a few years after going to Leadville, and thereby became familiar with various parts of the Leadville district.

To engage in leasing is a good way of acquiring knowledge concerning a mining district.

Francis T. Freeland, whom you remember, used to say that Robert B. Estey and I started the plan, which has since become common in the Leadville district, of leasing numerous tracts of contiguous ground and operating them as a unit. My first venture of this sort with Mr. Estey was started in 1893, when, after long negotiations, leases were secured from various owners on a number of pieces of ground at the east end of Fryer hill. There was some question as to the title of parts of this ground and in one instance it was arranged between the two contestants that the royalty from any ore shipped should be held in trust until eventually, through litigation, it could be determined to whom it belonged. This operation was carried on under the name of the Union Leasing & Mining Company. Shipments were large for several years, up to 1897 or 1898. Without co-operation it was impracticable for any of the owners of small acreages to operate in that locality because of the amount of pumping that was necessary, but with control of a considerable area the operation became feasible.

What caused you to leave Colorado?

In 1887 I was married to Della Mulock. In 1901 we left Colorado on account of the health of one of our children, moving to Los Angeles, California. For two or three years thereafter I spent a good deal of time in Colorado, but gradually drew away from that State to the Pacific Coast.

What new mining ventures or professional work engaged your attention on this Coast?

For several years after moving to Los Angeles, I spent more than half of my time in Colorado, in connection with the mining operations at Leadville, and also in connection with the work of the Empire Zinc Company, for which I acted as consulting engineer from 1902 to 1904. This branch of the New Jersey Zinc Company was under the local control of W. C. Wetherill, one of the finest and most charming of the older generation of engineers, and J. H. Troutman, who had been with the company for many years. This was to me a very pleasant association. The late W. C. Wilkens was in charge of the mining work for the company at that time, and I got to know him intimately, to my great pleasure and advantage.

You got your first capital, I presume, by saving your salary and then by small participations with your principals?

No, not exactly. I saved from my salary and commenced to lease with Mr. Estey and others in Colorado. Before leaving Colorado I had acquired enough so that when I was offered the position of consulting engineer on the Pacific Coast for the Guggenheim Exploration Company I chose to have no salary but a rather larger compensation for anything that might be found.

How long were you consulting engineer for the Guggenheims?

Only two or three years, during which time I brought to their attention at least two properties in which they became interested, first, the Dairy Farm in California, and second, the Utah Copper at Bingham, Utah.

Yes, I had the pleasure of reading the report you made on the Utah Copper in 1905 and I remember particularly your diagnosis of the economic phase of the proposed operations. Why did the Guggenheims drop this business?

They did not drop it; they took up the first convertible bond issue at that time. The common stock was already in the hands of the MacNeill and Penrose group.

If I remember correctly, you were consulted with regard to the drainage system of Cripple Creek?

Yes, I spent a few weeks studying the drainage of the Cripple Creek district in 1902. The situation was an extremely interesting one. Over a large portion of the district, the water-courses were so intimately connected that at a distance of half a mile the water-level would vary only a few feet. One shaft would have no water to pump whereas another shaft a half-mile away might be pumping one or two thousand gallons per minute at a depth only five or ten feet greater; when the first shaft was sunk twenty feet the burden of the pumping would pass from the second to the first. In this basin at certain horizons it was necessary to remove over a hundred million gallons of water for each foot vertical that was drained. There was very little influx, and when once drained the water gave little trouble. The old Standard tunnel discharged 17,000 or 18,000 gallons per minute for a few months, and for almost two and a half years discharged an average of over 10,000 gal. per minute. The obvious solution of the problem was a drainage-adit. This plan was adopted, the Roosevelt adit being the first of the drainage-levels driven. David W. Brunton and A. E. Carlton contributed much to the success of the drainage scheme.

As you gradually withdrew from mining affairs in Colorado, with what new enterprises did you become connected?

For the first few years much of my work was in connection with the Guggenheim Exploration Company on the Pacific Coast. I resigned in 1905. Early in 1907 the deal for the property now owned by the Ray Consolidated Copper Company came up. Philip Wiseman had seen this property some years before and was enthusiastic with regard to it. We tried for a number of months to get in touch with the right people. John Annan was the controlling spirit among the English group that controlled the Ray at that time, and William Young Westervelt was their American representative. The connection was finally made through Charles H. Cutting, then living in New England, and

through Mr. Cutting an understanding was reached with Mr. Annan, then in England. This property had been worked for some time by the English company, but the enterprise had not been profitable and the company was being financed by a small group of stockholders led by John Annan and J. G. Gordon. The earlier attempts to work the mine had been made with the idea that the ore was of rather a high grade. These attempts were initiated before a railroad was built to the mine. Much development work had been done, part of it under the supervision and direction of Alexander Hill. A concentrator had been constructed and operated, and probably some concentrate had been shipped. This concentrator worked only the richer ore, but the development work had exposed two or three million tons of 2% disseminated ore and the various scattered shafts gave strong indications that the property was to become one of the great copper mines of the world.

Of course, by that time you had the benefit and experience of the Nevada Consolidated and the Utah Copper?

Yes, and it was that experience that made the property seem particularly attractive.

Will you not say something about the acquisition of the Ray property?

When I first saw the Ray, Mr. Cutting and Thomas Kavanaugh had exchanged letters with Mr. Annan in regard to an option. Mr. Kavanaugh was on the property and on my arrival showed me a telegram from a mining operator offering him a cash payment of $5000 if he would go back on the understanding that he then had with Mr. Wiseman and me. This did not tempt Mr. Kavanaugh for a moment. A complete agreement was finally made with Mr. Annan, and the Ray Consolidated Copper Company was organized with a capital of 600,000 shares of $10 each and an authorized issue of $3,000,000 of 6% bonds convertible into stock at $10. The shareholders of the English company that owned the property took $400,000 of bonds, 122,500 shares of stock, and $100,000 in cash for the property, which was deeded to the Ray Consolidated Copper Company. The purchasing syndicate paid $100,000 in cash to the English company, put $100,000 into the treasury of the Ray Consolidated Copper

Company, and received in consideration therefor $200,000 par value of bonds and 127,500 shares of stock. The English shareholders gave to the purchasing syndicate an option on 61,250 shares, being half of their holdings, at $10 per share, this option being valid until February 1, 1909. Mr. Annan laughed at the request for an option on a portion of their stock at $10 and readily granted it, but before the option period expired the development amply justified the purchase of this stock at that price.

When did Mr. Jackling get into the business?

The original financing was accomplished in February 1907 through Sherwood Aldrich, Eugene P. Shove, Charles L. MacNeill, and Spencer Penrose, all of Colorado Springs. I am not quite sure whether Mr. Jackling was interested in the beginning or not, but shortly afterward he did become interested and soon became chairman of the executive committee and managing director of the company.

Did you and Mr. Wiseman have any interest in the enterprise, and do you still retain that interest?

Mr. Wiseman, Mr. Cutting, Mr. Kavanaugh, Robert D. Grant, and I obtained an interest in the stock of the company and all the survivors of our little group are still interested in it.

To what figure did the Ray shares rise?

I think $37 per share is the maximum price that has been paid for the stock on a capitalization of 1,600,000 shares. The shares that we bought from the English holders at $10 were on the basis of six million dollars for the property, the issue at that time being 600,000 shares. At $37 per share for 1,600,000 the property was valued at close to sixty million dollars. The stock prices for the last few years have usually represented a value of 35,000,000 to 40,000,000 dollars for the mine.

What are the prospects at the present time?

According to the annual report for 1919, the mine had 84,736,384 tons of ore averaging 2.063% copper, with possibilities for increased tonnage as the result of the extension of the orebody laterally and to a greater depth in certain portions of the property.

That must have been a most pleasant operation, both technically and financially. What did you do next?

Several smaller ventures followed. A very fortunate opportunity came in 1914 when Frank A. Keith got in touch with George A. Long and John L. McIver, who then held options on what is now the property of the United Eastern Mining Company. Mr. Long and Mr. McIver had worked underground in the adjoining Tom Reed property and had become convinced that the United Eastern ground would hold the continuation of the orebody. The data they had secured were not altogether convincing and it was only after several months of desultory discussion that an option was obtained from them at $25,000 for 51% of the stock issued. The shaft that they had started was sunk vigorously. All of the money paid for the stock was spent in exploratory work.

I suppose you would call this a beneficent wild-cat?

Yes, indeed, it was. We were very doubtful about the outcome, quite as doubtful as we have been with regard to many wild-cats that have long since been forgotten. It was one of the fortunate ventures that go to make up for the long years when one seeks and works and spends without any reward whatever.

Who were associated with you in this deal?

Frank A. Keith, Philip Wiseman, C. H. Palmer Jr., George D. Nordenholt, R. I. Rogers, J. E. Fishburn, and W. D. Woolwine.

How did the prospect pan out?

The shaft cut the vein at about 200 ft., but on that level only a few scattering assays were obtained; 250 ft. deeper a cross-cut to the vein went into the bonanza, the vein showing from 20 to 25 ft. in width of $20 to $25 gold ore. This proved to be the top of a very rich and large ore-shoot. A mill was erected and started in January 1917, and since that time has been running continuously, the tonnage having been increased gradually from about 200 to 300 tons per day.

How much has the mine produced altogether?

About 325,000 tons yielding over $7,000,000 gross, yielding a profit in excess of $4,000,000.

How deep is the mine now?

About 1300 feet.

Does the vein look healthy in the bottom?

The vein is of fair size in the bottom, but the ore has become poor. Further development will be done in depth in the hope that the ore may improve, and additional development work is in progress laterally. One of the greatest difficulties for the past two or three years has been the lack of men for work underground.

Speaking of the increased cost of gold mining, I would like to ask you what you think of the proposal to levy an excise of $10 per ounce on gold, as proposed in the McFadden bill now before Congress?

It impresses me as an extremely ingenuous and plausible proposal, but if passed, it will be because of the backing of the financiers, for there seems to be absolutely no chance of its passage in the interest of the producers of gold. The passage of this bill would increase the production in this country somewhat and the cost of it would be borne not by the Government but by the jewelers and other manufacturers in such a way that the people at large would feel it very slightly. As to the soundness of it from a financial standpoint, I hardly know what to say. What is your opinion on that?

I think it a form of class legislation to which we ought to resort only in case of extreme national necessity, which I believe does not exist. In any event, unless I am much mistaken, the prospects of the bill passing Congress are and have been extremely small. You have been interested in a sulphur enterprise I believe in Texas, have you not?

Yes, about 1910 I was in charge of an examination of a sulphur property in Texas for a group of New York capitalists led by Bernard M. Baruch. At that time I asked my chief assistant, Spencer C. Browne, to look over Texas carefully for other possible sulphur-producing territory. This investigation indicated that the property of the Gulf Sulphur Company, near

Matagorda, in Texas, was very promising. Shortly afterward negotiations were started and a stock interest was purchased. By 1917 nearly all the stock of this company, which owned about 400 acres of ground, had been acquired. Today between two and three thousand acres are controlled. The name of the company has been changed and it is now known as the Texas Gulf Sulphur Company. During 1917 systematic development of the ground was begun, by drilling.

What kind of drilling?

With the rotary oil-rig, which is so commonly used in California. The overlying eight or nine hundred feet of material is made up of occasional layers of limestone in 'gumbo', which is a partly consolidated marine mud. The ordinary rotary drill was especially suited to penetrate such material.

How do you win the sulphur?

This is won by a process quite similar to that developed by Herman Frasch in Louisiana. The sulphur is melted underground by water heated to a temperature of 300° to 350°; after melting, it is pumped to the surface by an ordinary air-lift and is stored in vats made of planking. These vats are as much as 200 ft. wide, 300 to 1000 ft. long, and 30 to 50 ft. high. The sulphur is pumped from underground with little, if any, admixture with water and after being pumped into the vat it cools gradually, and solidifies. When the vat is full and the planking removed one sees an enormous block of solid sulphur lying on the ground. The sulphur is blasted and then loaded by a Brown hoist into railroad-cars.

For what purpose is most of it used?

Much of it is used in the paper trade, much is used in making high-grade acid and also acid for the fertilizer industry, and a considerable tonnage is ground and refined for use in orchards and vineyards.

Can you tell me anything about the financial side of this enterprise, that is to say, how much capital was required and how fruitful it became?

The investment was over six million dollars. The result has been satisfactory, assuring an ample reward for the risk and expenditure involved.

Have you done any mining in foreign countries?

I have mined more or less in Mexico, of course, but have never been connected with large operations there. I have been interested in ventures in other foreign countries, but none of them have come to fruition except one in the island of Cyprus. About ten years ago, Mr. Wiseman and I, together with three others who have since died or dropped out of the enterprise, engaged Charles Godfrey Gunther to look for likely property in this country and Mexico. After searching fruitlessly for several years, it was decided that there was an opportunity around the shores of the Mediterranean. Under Mr. Gunther, search was made in the libraries of this country and Paris and London for information that would guide him to promising districts. On his first trip, after going to the Mediterranean, he started from the Red Sea with a dozen camels and as many cut-throats of the polyglot population and went to Mt. Sinai. There was copper there, but the conditions were not favorable.

Did Mr. Gunther find evidence of any large-scale copper mining operations?

No, not in that district. Apparently some copper had been mined on the Sinai peninsula and the evidences of turquoise mines were numerous. Mr. Gunther then visited a number of places around the Mediterranean, Northern Africa, Spain, Sardinia, Asia Minor, and adjacent regions, but he found nothing of exceptional interest until he went to Cyprus. That island shows the evidences of Roman and Phoenician mining at a number of points, but there are only a few where the slag-heaps indicate that the operations were large. The conditions existing at the place where the largest accumulation of Roman and Phoenician slags was found were so favorable that Mr. Gunther was confident that a mine could be uncovered. This was at Skouriotissa, five or six miles from Morphou Bay and about twenty miles west or south-west of Nicosia, the capital of the island of Cyprus. A prospecting permit covering a square mile was obtained from the English governor of the island. Mr. Gunther

then returned to this country and about a year later took back with him a drill such as has been used to develop the 'porphyry' coppers. Drilling was started in the latter part of 1913 or the early part of 1914, and the present orebody was being developed when the War started between Germany and the Allies. Operations were hampered and, finally, drilling was discontinued on account of a lack of supplies; it was not until about a year ago that drilling was resumed. During the interval, however, Mr. Gunther did a large amount of underground work and built a railroad to the shore at Morphou Bay.

What is the character of the orebody?

The ore is a massive iron pyrite containing about 2¼% copper, something less than $1 in silver and gold, 47 to 48% sulphur, and remarkably free from arsenic and other elements, deleterious to acid-making. The orebody now developed covers about twenty acres and has an average thickness in excess of 60 ft. with a maximum thickness of 130 ft. or more.

What evidences have you found of the work done by the ancients?

There is approximately one million tons of slag on the property, perhaps half of it having been made by the Phoenicians and half by the Romans.

What does the slag assay?

The Phoenician slag contains a little less than 1½% of copper; the Roman slag about ¾%.

Do you think there is any chance of beneficiating any of this slag, especially that left by the Phoenicians?

Yes, there is a possibility of developing very considerable bodies of the concentrated ore as well as additional tonnages of massive sulphides. A smelting operation would probably bring the Phoenician slag into use. There are several depressions in the surface indicating caved stopes below. Some old openings appear on the surface and large areas are covered with dumps from the ancient mining operations. Underground we have cleaned out two or three thousand feet of ancient drifts. These are small, about four feet high, rather less than three feet wide, narrow at the bottom, widening where a man's shoulders would have to pass through, and arched on top. The character of much

of the ground was such that these drifts still stand perfectly, except at the intersections, or where the openings were unusually large.

Have you found any ancient implements?

A few lamps, which were made about the time of Christ. Sticks and fragments of pottery have been found, but no implements. Occasionally in the slag-dumps a little metallic copper is detected and one blacksmith's dollie was picked up, fashioned to put a blunt point on copper rods of four different diameters. Several spiral raises with a diameter of 45 ft. have been opened up. These evidently were used for ingress and egress. At one point there is about an acre of fragments of ancient earthenware pots, which may represent the waste-heap of an ancient sulphur refinery, for in one of the caves the floor was covered to a depth of two feet with material that resembles the ash remaining after distilling sulphur, and in one corner of this ancient cave there was a broken pot partly filled with fine sulphur. Possibly water troubled the ancients, and these earthenware pots may have been used by slaves in carrying water from underground.

You ought to find some implements in the old dumps?

The copper dollie referred to is the only one I know of.

Colonel Mudd, you did a good deal of work for the Government during the War, I believe. Will you please state the nature of it and the impressions that you obtained from it?

I was one of the assistant-directors of the U. S. Government Explosive Plants, a separate administrative unit, set up by the Secretary of War. D. C. Jackling was director of this unit, whose principal work was the erection of the smokeless-powder plant at Nitro, in West Virginia, which was designed to produce 800,000 pounds of cannon powder per day.

The site selected was a cornfield; it was necessary forthwith not only to build wagon-roads and railroads, and erect the plant itself, but to provide dwellings, bunk-houses, restaurants, stores, Y. M. C. A., church, movies, hospital, electric lights, waterworks, and everything else to accommodate 20,000 people. By August, or within eight months, some powder was being produced in this plant. When the Armistice was signed, a plant

with a rated capacity of 800,000 lb. of smokeless powder per day was 90% completed and the daily output had already reached an important figure. The plant included buildings and apparatus for making sulphuric and nitric acids, for the purification and nitrating of the cotton; for poaching, boiling, dissolving, and transforming it into a jelly; for passing this jelly through the dies; for drying, testing, packing, and shipping this powder finished and ready for use.

Finished powder varies in size of grain depending on its use. Small arms powder has over 300,000 grains to the pound; 14-in. cannon powder has seven or eight grains to the pound, each grain being 1⅛ inch in diameter and 2¼ in. long. It looks more like brownish molasses candy than like a violent explosive.

The Nitro plant is situated in a bend of the Kanawha river and covers an elliptical area about 3½ miles long and 1¼ miles wide. There were in all between 3300 and 3500 buildings constructed. The total expense was $60,000,000. From first to last 90,000 men were employed at this place, but at no time did the total number of employees exceed 19,000, excluding a military guard of about 500. The usual difficulties prevalent during that period were encountered in securing labor, supplies, and prompt transportation. Privately owned powder-plants grew like mushrooms between 1914 and 1917, and it is a satisfaction to know that America was able to supply not only her own needs but to furnish the Allies with large quantities of smokeless powder from a time shortly after Germany attacked France until the Armistice was signed.

There has been and will be much criticism of war work; but considering the lack of comprehensive general and detailed plans of all that was necessary to carry on a war, the urgency of the need, and the consequent sacrifice of everything to speed, the multitude of new things to be done, and the lack of training for these new duties, I consider the accomplishment of the nation and of nearly all the men with whom I was brought in contact was extremely creditable. The spirit of unselfish service was dominant in Washington and self-interest rarely obtruded itself. Mistakes and inefficiency were common enough, but this was inevitable in anything that had such a marvelously rapid expansion as the war activities of this country. It appears that the personnel of an army can be secured and given some

training more rapidly than proper equipment and supplies can be provided. Military training of our young men is extremely desirable, but our people will make a greater mistake if they fail to force Congress to pass such laws and provide such funds as will ensure ample equipment and supplies for any possible future war.

Mr. Mudd, are your sons to become mining engineers?

One of them was graduated from Columbia College as a mining engineer in 1912. The other is studying medicine at the University of California.

How would you compare the condition of the mining industry as you knew it when you started with its status today?

When I started, a trained engineer was subject to the sneers and contempt of many of the practical men. That is rapidly disappearing; the engineer is coming into his own. The spectacular development of the past few years in some of the enormous porphyry coppers has given us a larger perspective; it is not unusual now to look for a property having a life of ten or twenty years instead of as many months.

In other words, the industry has been stabilized?

Yes, decidedly. It is certainly much more satisfactory to have to do with an industry that is stabilized rather than one on which you cannot count from year to year.

How would you compare the standard of conduct obtaining in mining affairs 35 years ago with the present standard?

The standard has been raised very greatly. Collusion and dishonesty between the sellers of machinery and supplies and those in control of mining operations was frequent then, whereas now it is practically unknown. The standard with regard to the selling of stock to the public has also been raised considerably, but it needs further improvement.

How do you regard the opportunities offered to a mining engineer with those that were offered in your time?

They are better. His opportunity to obtain an excellent training with many of the larger corporations and better established engineers is larger and better than it was 35 years ago.

The chances for stable and satisfactory employment are much more numerous. The openings for making money, although of a different type, are, I think, greater than they were.

Of course, the salaries paid today to a successful mining engineer and even to a young man are much higher than in your time and mine, and therefore a young man obtains the necessary capital with which to participate in mining operations much sooner than he used to?

Salaries are not only higher, but higher in proportion to the cost of living; opportunities for saving are greater and the tendency to allow the young men to participate is also increasing.

You believe then that it is a good thing for the members of the profession to participate with their principals?

Yes, I do, but when this is done there must be absolute frankness, and even with this frankness, if the results are not satisfactory, one takes risk of criticism. It is good to risk one's own money on just the same basis as that of the other investors, or one's clients, showing good faith and confidence as completely as possible.

If it were all to do again, would you prefer to be in some other profession?

No, I know of none in which I think I could have gotten as much enjoyment, made as many good friends, and in which I would have had an opportunity to participate in the initiation of work that has meant opportunity and livelihood to so many.

FROM LEADVILLE TO CYPRUS

*The mining engineer makes the whole world his patrimony; the American members of the profession have lived up to this tradition in recent years, although previously they were more stay-at-home than their English friends, for the good reason that our country happens to be continental in its extent and mineral resources. Latterly the American has been directing mining operations in the remotest corners of the earth, from Okhotsk to Tanganyika, from Suan to Chuquicamata. He has also investigated the ancient mining districts of that cradle

*Editorial in the 'Mining and Scientific Press' of November 13, 1920.

of civilization, the Mediterranean. Not long ago we referred to the exploratory work done by engineers of the General Electric Company on the Sinai peninsula; this week we give sundry particulars concerning prospecting in old workings on the island of Cyprus. The information comes in the course of an interview with one of the leaders of our profession, Mr. Seeley W. Mudd, now a resident of Los Angeles. As a man is more interesting than a mine, so Mr. Mudd is more engaging than a Cypriot prospect; or, if you like to look upon a man as a 'prospect' in another sense, you will find that the sample we have taken pans well; it shows the pure gold of good citizenship. Mr. Mudd is evidence for the efficiency of the American melting-pot; his forebears came from several racial stocks, which have been so roasted, smelted, and refined in the laboratory of American life and tradition that the product, after two or three centuries, is an unmistakable type, the *civis Americanus*. Mr. Mudd had the best education available in his youth, but he recognizes how much the technical training of today is better than that of forty years ago. Later he underwent an apprenticeship that any intelligent member of the younger generation might well envy. In the first place, he had a chance to do all kinds of work in a smelter immediately after leaving college, and then, when he went to Leadville, he engaged in the leasing of mines on his own account. We regard leasing as an invaluable experience, because it helps a young engineer to acquire judgment and initiative, besides teaching him unforgetably that the purpose of mining is to make money. It is not given to every young man to engage in mining on his own account, for to do that he must have some capital, but if he can obtain the experience it is likely to make him a reliable consultant in after years, provided the pursuit of wealth does not make him a wild optimist, which is the result of the *sacra fames auri*, as, indeed, of the hunger for baser metals. In our published interviews with successful engineers it will have been noted how often a successful turn in a man's career is due apparently to an accident. Mr. Donaldson chose to go to the mine in Oregon, thereby resigning the management of the Small Hopes to Mr. Mudd. On his connection with that famous mine was laid the foundation of his career. First he had the experience of managing the Small Hopes in its bonanza stage and later as a depository of low-grade ore. He was given charge of other mines

distinguished by a variety of geologic structure and operated under diverse economic conditions. His leasing operations, as we have said, were particularly valuable in developing the qualities of discrimination and sagacity that became personal characteristics as he advanced in his career. In the end he became connected professionally with the biggest mining ventures in the West. The Ray laid the basis of his personal fortune. It is interesting to note his confident foresight in contrast with the narrow vision of the former British owners; when worked on a small scale as a high-grade deposit, the mine was a failure, but when exploited as an immense deposit of low-grade ore it was made enormously profitable, thanks to the constructive imagination of an alert and experienced engineer. An English mining engineer of recognized ability and high character, the late Alexander Hill, opened up the Ray in the first instance, unfortunately too soon to take advantage of the improvements in technical practice in mine and mill that made it possible to exploit copper ores with a cheapness now no longer remarkable. Mr. Mudd's adventure in the United Eastern was a smaller affair, but likewise extremely profitable. We have heard it said that the United Eastern, in plan and execution, was one of the neatest mining enterprises ever started and brought to fruition by one man or a group of men, for in all his operations, of course, Mr. Mudd has had the loyal assistance and intelligent co-operation of several friends, also mining engineers. That points at another characteristic invaluable in all kinds of large endeavor: he arouses loyalty and wins whole-hearted assistance in his work. He does not play that miserable game called 'the lone hand'; he likes to have partners, and he does not forget them in the hour of success. Moreover, the younger men tell us that he goes out of his way to help them and that he remembers his obligations beyond the letter of the contract; in consequence, he has what is too often denied to the rich and successful: the respect and affection that no money can buy. In his engineering work, when appraising a mine or planning a scheme of operations for a new mine, he shows the care and caution that the circumstances require; he has no use for hearsay or guessing; he anchors his plans to the facts as determined by thorough investigation. He is not an optimist, nor a pessimist; he has a sense of proportion. He can see the other man's point of view; and that makes him tolerant. A quiet philosophic ap-

preciation of things as they are renders him fair in his judgment of the issues arising between capital and labor. His remarks on this subject indicate humaneness; they suggest that some men can acquire the privileges of wealth without forgetting their obligations as employers of labor. Enterprising always, in the later years of his life he has engaged in a romantic mining venture in Cyprus, where he, Mr. Philip Wiseman, and other friends have uncovered and explored sundry ancient copper diggings. He gives an interesting account of them. During the War this enterprise had troubles of its own, as might have been expected, but he forgot them in his devotion to the national service. As early as August 1916 he applied for a commission in the Engineer Officers Reserve Corps, and on February 12, 1917, he received his commission as a Major. In 1918 he was made a Colonel in the U. S. Army. He was assistant to Mr. D. C. Jackling, the Director of the Government Explosive Plants, who had supervision of the building of the big Nitro works in West Virginia, a part of which only could be shown in the photograph that we print with the interview. In his concluding remarks Mr. Mudd exhibits the essential sanity and the cheery outlook that have marked him during the whole of his career. He believes in mining and has a worthy son to follow in his footsteps; he recognizes the broadening of the mining industry and the enlarged scope for engineering on a big scale; he is of the opinion that the code of conduct among members of the profession has improved. He has helped to improve it. He can look back and be grateful for unusual opportunities and remarkably good fortune, but most of all he is happy in having found work and opportunity for others, and for the many friends he has made. He has more of them than he knows.

HENRY C. PERKINS

AN INTERVIEW

Mr. Perkins, where and when were you born?

On Staten Island, New York, in 1846.

Where were you educated?

I attended schools in New York City, at Canaan, New Hampshire, at North Middleborough, Massachusetts, at Eagleswood, New Jersey, and finally I was a cadet at a military school on Staten Island kept by M. Pujol, a Frenchman.

Did you have any special education for the mining profession?

I did not.

How did you chance to become connected with mining work?

When 17 years of age I was invited to accompany to California a cousin who had married Frederick Law Olmsted. Mr. Olmsted was general manager for the Mariposa Commercial & Mining Company, which was engaged in the development of the gold mines on the Mariposa Grant in Mariposa county. I was engaged in office work for the company when it ceased active mining in 1865.

What did you do then?

In October 1865 I entered the office of the New Almaden Quicksilver Mining Co. in San Francisco, where I served under the company's general manager, Samuel F. Butterworth, until 1870, first as assistant-accountant and then as accountant. At the same time I was secretary of a company that was mining borax and sulphur in Lake county. This company, by the way, I believe did the first mine dredging in California. The superintendent, C. W. Lightner, devised a bucket-dredge operated by hand-power. This was used to extract borax from Borax lake.

Where was your next work?

After a few months at New Almaden in charge of the office there, I went to North Bloomfield, in Nevada county, where as assistant to General A. M. Dobbie I became interested in testing

the quality of the gravel in the ancient river-bed system. In 1871 Hamilton Smith was appointed manager of the North Bloomfield company and I became his assistant while he projected and started a bedrock tunnel to drain the deep channel. This tunnel was some 8000 ft. long in hard rock, and with the assistance of eight shafts the work was accomplished in less than three years by handwork, excepting in the lower face where a diamond-drill was employed. The total cost of this tunnel was a little under $500,000. At the same time larger storage-reservoirs were constructed in the mountains, some 40 miles distant, and the canals connecting them with the mine were enlarged and improved.

Was Hamilton Smith a trained engineer?

Yes, he had trained himself by practical work in his father's coal mines in Indiana.

He was a man of great natural capacity for engineering work?

Yes. He was a masterful character, he had a powerful intellect, a great grasp of the controlling factors in any undertaking, and a genius for thoroughness. The most important incident in my career was my association with him, which lasted until his death in 1900.

What was Mr. Smith's later work?

In 1874 he turned over to me the superintendency of the North Bloomfield company and moved to San Francisco, where he was elected president of the company. While there he brought Baron Edmond de Rothschild to inspect the hydraulic mines at North Bloomfield. Through this introduction he became the consulting engineer for the Rothschilds in Paris and London. For them he first inspected and reported upon the El Callao mine in Venezuela and subsequently advised them upon their mining affairs generally. Hamilton Smith was instrumental in introducing abroad the greater number of those American mining engineers who have brought so much credit to the profession. His figure bulks largest among the mining engineers I have known.

How long did you remain at North Bloomfield?

I remained in charge of the North Bloomfield company's properties and also those of the Milton company until 1883, when the attacks of the farmers, assisted by the Federal gov-

ernment, against the hydraulic miners, who were charged with destroying farming land and injuring the rivers and harbors, became so harrassing and expensive that I saw that hydraulic mining in California would be no longer profitable, and I therefore accepted an offer to go to Venezuela, and assume charge of a valuable gold-quartz mining property there for a term of three years.

How long did you remain in Venezuela?

I managed the El Callao mine for four years, that is, from 1883 until 1887.

This was your first experience in mine management in a foreign country and with alien races?

Yes, and I found my experience valuable. I learned two things that have been of great assistance to me.

These were?

First: I learned that a foreigner in a strange country, irrespective of the character of the people and its degree of civilization, should assume that the great principles of right and justice do not vary with different races, nor with different degrees of civilization. Those principles are universal and everlasting, and they should govern our actions always—not only where and when they seem advantageous. My observations have brought me to the conclusion that disasters that come to us abroad in dealing with the authorities have been nearly always the result of our departure from those first principles, whether the departure was owing to ignorance, accident, or design.

Second: I came to the conclusion, which has been confirmed by my later experience, that the differences in the intellectual, moral, and physical qualities of people are not racial, but are owing to local influences to which communities are subjected by education, opportunity, temptation, and particularly by the impress of masterful characters. I believe that there is not 25% difference in the intellectual, moral, and physical value of the various races of the world when they are submitted to the same influencing factors.

In mining work is it possible to bring these influences to bear upon the uneducated and semi-civilized races in a reasonably short time?

My experience indicates that the time required is surprisingly short, and I have concluded that when planning a long campaign of work, if the locality has an ample population, it is better to employ the local inhabitants in any kind of work, the simplest or most difficult, rather than to import labor from abroad. I make the proviso, however, that the effort must be made by those who are sympathetic with the race they employ, they must believe in the principle and they must have patience. These conclusions I have arrived at after a long experience in employing many races, white, black, and yellow for various kinds of work.

Probably not more than 10% of the individuals of any race are especially adapted by mental temperament and physical qualities to become very efficient in any particular task. Therefore to accumulate 100 of the most efficient workmen for any special employment, it will be necessary to select, by a process of elimination, this number out of 1000. For this reason an ample supply of men from which to choose is a highly important factor in securing the best results.

What is your opinion concerning the Chinese episode at Johannesburg?

I think it was a mistake; where an ample indigenous population is available it is better to train the natives for permanent work rather than to import foreign labor, although doing this may promise better immediate results. At the time the introduction of Chinese labor on the Rand was proposed I took this view; the reply was that an insufficient number of Kaffirs was available—a good reason if this had been a fact, which it was not, as is now known.

Then you have come to the conclusion that in a long campaign of industrial effort it is better to employ the people of any populous neighborhood rather than to import labor from a distance whatever the race or prevailing state of civilization may be? If I am correctly informed, Mr. Perkins, you adopted the policy later when you were in Korea?

It would not be quite true to say that, because the policy was adopted by the men who preceded me. The policy had been forced by circumstances, but I accepted it and developed it sympathetically. When our company, the Oriental Consolidated,

started to work in Korea, the population in the neighborhood of the mine was almost exclusively agricultural, yet within three years the natives had learned to run the machinery, and were doing nearly all of the work of building mills, assaying ore, blacksmithing, as well as the underground mining. We have employed 5000 natives, with less than 60 white men, the latter chiefly in the accounting department, keeping tally of the stores, and handling and transporting the bullion. This number includes the manager and his staff. It suggests what can be done with an ignorant and entirely untrained people in a short time by making a sincere attempt to teach them how to be useful.

What was your experience in Venezuela?

In Venezuela we employed chiefly negroes from the West India islands, there being practically no local supply of labor. These negroes, whose only previous training had been in agricultural work, for which they were paid about 25 cents per day, came to the mines and were paid $3 per day. They soon became expert in nearly all kinds of mining labor, and, after some improvement in organization, with these men we produced and reduced the ore from the gold veins nearly as cheaply per ton as they did at that time at the Mysore mines, in India, where the laborers received only some 20 cents per day. The mining difficulties so far as width of lode and hardness of ore were concerned were practically the same. My mining experience in Mexico justifies me in making the assertion that the mining cost there materially exceeds the cost in the United States, where the rate of wages is more than double.

Then you consider that the rate of wages is not an important factor in the cost of mining?

In certain cases it is an important factor, but I have come to the conclusion that usually its importance is much exaggerated. In estimating the value of a mining property I do not consider the rate of wages prevailing, however high or low it may be, as a vital consideration.

As an illustration of the effect of the rate of wages upon the cost of mining I give the following table:

	Miners' wages	Cost per ton
Venezuela, in 1887	$3.20	$15.00
Mysore, in 1887	0.20	13.00
Alaska Treadwell	3.50 to 4.00	1.25
Mexico	0.50 to 0.75	4.50 to 5.50
California	3.00	2.50 to 3.00
Korea	0.25	2.50
Rand	0.75	4.00 to 5.00

In the Alaska Treadwell mine the great size of the deposit makes the conditions exceptional, otherwise I think the above comparison fairly indicates the singularly small effect that the rate of wages has upon mining costs. In India and on the Rand the unnecessarily large proportion of highly-paid foreign employees accounts materially for the high cost per ton in those localities.

Where did you go after leaving Venezuela?

I went to London and joined the firm of Smith & De Crano. This firm had previously established the London Exploration Company.

What work engaged your attention while a member of that firm?

I first examined gold mines in Mexico, and later the Anaconda property in Montana. I then examined the Alaska Treadwell group of mines in Alaska, and my firm purchased for the Exploration Company the control of these mines. I placed Capt. Thomas Mein, who had been my assistant in Venezuela, in charge of them.

After returning to London, Smith & De Crano assumed the management of the London Exploration company and I established an office in that city for consulting work. I was appointed consulting engineer to the DeBeers Consolidated Mining Co., but this position was nominal, the direction of affairs being entirely in the hands of Gardner F. Williams.

How long did you remain in London?

For five years; until 1893 it continued to be my headquarters; during this period, however, I traveled extensively on mining examinations and undertook the development of a gold mine in Wales, which proved to be unprofitable.

Where else did you go?

In 1891 Lord Randolph Churchill decided to make a trip into Mashonaland, which in August of the previous year had been occupied by the British South Africa Company. Having been introduced to Lord Randolph by Lord Rothschild, I was invited to accompany the former as consulting engineer. Mashonaland was reported to contain valuable ore deposits.

How long did the trip take?

Some nine months, five of which were spent in Mashonaland and the remainder in traveling and observation in other mining districts.

What was your opinion of the mining prospects of Mashonaland?

I found gold widely distributed there, and while at many places I saw rich ore, the veins and deposits were generally too small and irregular to justify a foreign company in undertaking their development.

Did you also visit the Matabele country?

No; at that time it was controlled by the Matabeles, who did not permit white men to explore for mines.

Then your trip into Mashonaland as a mining venture was a failure?

Not entirely so, for on my way up the country I visited Johannesburg and became much interested in that district now famous as the Rand.

What were the conditions of the mining industry in the Transvaal at that time?

The banket gold deposits discovered some five years previously had had their first period of development with the inevitable share boom, which had collapsed, the first expectations not having been fulfilled. At that time several of the companies had paid dividends, but none except the Robinson, the ore of which then yielded $40 per ton, had earned any actual profit, if the loss in scrapping inefficient plants were considered. In consequence the European investing public had largely lost its enthusiastic view of the value of these mines, and the shares were much depressed in value.

You thought at that time that the profitable ore would persist into the untested ground on the dip of the conglomerate beds?

Yes. J. S. Curtis had previously advocated that view. It was obvious to anyone of mining experience. After looking over the situation I came to the conclusion that the district had a large intrinsic value, which would be demonstrated by improvements in methods, equipment, and management. I therefore took an active part in the development of the ground below the outcrop mines and after returning to London I interested large London and Paris financial houses in the mines of that district. In 1893, I was engaged by the firm of Wernher, Beit & Co. to manage the development of deep-level properties for a period of three years.

What sort of treatment did you get from the Boer government?

I thought that the government by the Boers was very good, considering the difficulties and temptations which the young nation was called upon to meet with so short a time for education in the new work suddenly imposed upon it. I saw no just grounds for complaint except the oppressive dynamite monopoly and the difficulties thrown in the way of obtaining the franchise necessary to obtain any control over the taxes, which were almost entirely borne by the foreigners. This grievance, however, was rather academic than real, for the taxation was not excessive and few of the foreigners wished to become citizens, although naturally they chafed at the control over their persons and properties by an authority which many considered unfriendly.

The critical and hostile attitude of the foreigners toward the Boers and their government I thought was both irritating and unjust to them. This, with the world-wide unfortunate racial prejudice, brought about that great tragedy, the Boer War.

You finished your term of three years on the Rand, and then?

I returned to Europe in 1896 and formed a partnership with Hamilton Smith. This association continued until his death in 1900.

What have you done since 1896?

I remained in Europe until 1898; in that year I returned to New York, where Mr. Smith and I established an office in

which we cared for our various mining and other interests. In the following year I inspected mines in Korea, Siberia, Canada, and the United States, and in all of these regions I became interested in mining properties.

When you first went to Korea, in what condition were the mines?

I went there with Leigh Hunt in 1900 and inspected the country 70 miles south-east of the Yalu river in north-western Korea. There was not much ore to be seen, and the gold was distributed in the quartz in a patchy way, making it difficult to estimate the available tonnage of ore. Mr. Hunt's company had done considerable development of the veins, extracting the rich ore wherever it was found. When I visited the propertv little good ore was in sight.

Did you sample the veins?

I did very little sampling. I mapped the work done by Mr. Hunt's company; an inspection of the maps showed that the ore had occurred in isolated spots and not in zones or shoots. After calculating that the yield of gold per square foot on the plane of the vein for the entire exploited ground had been $4 per square foot more than the reduction cost, I came to the conclusion that these veins could be worked profitably if they persisted in length and depth; and as there were no indications of their early giving out, I decided the venture was a good one. I have often employed this method of appraising the value of a mine. In other words, the question to be decided usually is not what can be earned by the mining of some tons of ore, but will the aggregate yield of gold be greater than the aggregate cost.

The experience of the Oriental Consolidated Mining Company in Korea has been interesting and instructive?

This company gained possession in 1897 of the mining rights on a concession in north-western Korea covering some 400 square miles of territory. Scattered indiscriminately over the area were many quartz veins carrying gold, in granite; the veins were generally small, the largest being rarely over six feet in width. The ore was refractory, carrying a large portion of the base metals.

The population in this locality was devoted usually to agricultural pursuits; what little quartz mining had been done had

been performed by the primitive operation of gadding out seams of the richer ore, which was ground under rolling-stones and the residue panned to obtain the gold contents. The population had had no experience in the use of modern mining equipment. Local wages were 10 cents per day; the company paid the miners 25 cents per day at first; later this rate was somewhat increased. The communication facilities of the country were of the most primitive kind—the roads were almost impassable, the bridges were removed in the rainy season and were replaced each year.

In the past 19 years the company has erected six mills with 245 stamps, three cyanide works, and a hydro-electric plant, including a dam 80 ft. high. It has established four general stores and a transportation service employing five vessels. It has mined and reduced 4,300,000 tons of ore, which yielded $22,500,000, and it has paid in dividends to the shareholders $7,500,000. To accomplish this it has used only some $100,000 for development of the mines and the equipment of the property; everything other than that sum has been paid out of profits. The company has employed from 3500 to 5000 natives, and rarely more than 60 foreigners.

Considering the low grade of the ore treated and the isolated character of the locality, the results certainly have been remarkable. In your opinion what were the chief factors in accomplishing these?

First, the lack of capital; this compelled the most rigid economy in the early days of the enterprise.

Second, the almost exclusive employment of native labor that was patiently trained to effective work by the small force of foreigners.

Have you any trouble now with the Japanese Government?

My experience with the Japanese has indicated to me that those of the official class controlling the Japanese Government affairs are broad-minded and clear-headed, whatever their final motives be. I do not question their good faith; I think they have too much sense to adopt a policy that is not just. My experience has been that while they have been exacting, to our cost and inconvenience, I cannot say that their action has been unreasonable or unjust from their point of view.

They certainly have benefited the Korean people in all material matters by their excellent government—whether these benefits have compensated the Koreans for the suppression of their national spirit, I am not sure.

I think that while the Japanese will not interefere with the operation of enterprises already in existence, they do not favor any new incursion of foreign capital into Korea, unless with very considerable and inconvenient restrictions.

You have then had over 50 years of mining experience.

Yes, and I have learned many things.

Will you mention some of the things you have learned?

I have already referred to the result of my experience in working in foreign countries and to my conclusions as to the influence of wage-rates upon mining costs.

The knowledge of mining costs you think a fundamental part of mining engineering?

Decidedly so. The first aim of the ore-seeker is to make a profit. If he fails in this he ceases to mine, and the world loses the benefit of his production of the metals.

Has the science of metalliferous mining advanced during the fifty years of your experience?

Certainly.

What influences do you consider have chiefly brought about the improvements?

In my opinion over 90% of the progress is due to the following three agencies.

1. The work of the chemist and metallurgist. They have improved reduction methods, explosives, and the value of alloys.
2. The engineers, who have introduced labor-saving contrivances.
3. The general education of the managers of mines and their use of more scientific methods.

In what direction do you look for further advances in mining efficiency?

Doubtless the chemist, metallurgist, and engineer will be of

further very material benefit, but probably the greatest advance will come from a better understanding of the proper relations between the employer and employee; in metalliferous mining usually the largest expense is labor, and by obtaining the best results from labor most important benefits will follow.

What do you consider the best method that can be employed for increasing the efficiency of labor?

A sympathetic study by the employer of the point of view of the employee, and a system of profit-sharing that will tend to give the employee the point of view of the employer. The raising of wages cannot go on indefinitely without resulting in the closing-down of the poorer mines.

What is your opinion of mining as a business investment?

While mining has its venturesome side—made especially attractive by the almost limitless possibilities of profit—the general impression that all mining investments are peculiarly hazardous and speculative is, I think, wrong. In my experience some of the soundest business men I have known have been persistent investors in mines. In choosing their enterprises they have not been led away by the temptation offered by optimistic promoter's circulars, but were guided by sound consideration of the statements made by men of character, ability, and experience.

Mining has its peculiar risks, but broadly speaking, no business enterprise is free from risk, although it may be of different character and come from different causes. The risk of mining, of course, is obvious to any man with mining experience; it is obvious to us mining engineers, just as the risk of farming and real-estate speculation is obvious to farmers and real-estate agents. That man is wise who deals in the things the risk of which he understands.

Therefore, Mr. Perkins, you will agree with me, I believe, that the mistake made by the public is not in considering metal mining a desirable form of using money, but the forgetting of the fact that it involves risk. Do you consider metal mining a legitimate form of investment?

Yes, I do, when the profit is sought from mining ore and not from kiting shares; in other words, by the legitimate return on capital and not by the fictitious enhancement of the principal.

'Income' from mining investments is apt to be a misleading term if one forgets that the income includes, in large measure, a return of capital. Many people who are accustomed to other kinds of investment overlook the necessary amortization of capital. Personally I charge the return from a mine to 'capital' until all the capital has been redeemed, and thenceforward I regard the return as profit. Moreover, I recognize that it is a profit that may cease at any time.

What is your opinion respecting the propriety of managers of mining companies—whose shares are on the market—dealing, except as investment, in the company's shares?

While there is nothing in itself dishonest in their doing this, I consider it a dangerous habit. When a man prays to be delivered from temptation he should not invite it.

You have known of many large fortunes accumulated through mining investments?

Yes.

Have these been made by share speculation or in a legitimate way?

I believe that almost without exception the large mining fortunes have been made by investment in mines that have yielded their owners a profit by the extraction of minerals from the ground, and that few, if any, of the large sums coming from purely stock speculations have resulted in permanent fortunes. Nor do I think mining promoters often have been successful in accumulating fortunes that have endured, excepting when they have dealt in mines of intrinsic value.

Do you favor publicity in the conduct of public companies?

I think that the shareholders in a public company are entitled to know everything as to its affairs that the management knows, and that hiding is not only indefensible but it is nearly always injurious to the best interests of the concern. Suppressing information deceives the unwary and aids the dishonestly disposed. Secrecy concerning the operations of a public company tends to create suspicion in the minds of the subordinates as to the good faith of those in control, it is likely to lower their moral standards and to discourage their enthusiastic co-opera-

tion. I am aware that the policy of secretiveness is often followed from good motives, but I believe it usually proves to be a mistaken policy.

To what, in your mining experience do you look back upon with the most satisfaction?

To the development of personalities and to the advancement of my subordinates from inferior positions to those of greater responsibility. I have been able to start a considerable number of young men on careers of great usefulness, and I have not felt that they were in debt to me for their successes, for the benefits arising from the association have been mutual.

What do you consider the chief factors you have employed in the development of these men?

The throwing upon them of responsibility and showing trust in them.

What qualities do you chiefly look for in selecting mining managers?

1. Strength of character.
2. An honest intellect which sees the facts as they are and not only as one may wish them to be.
3. A disposition to be just to the employee as well as to the employer.
4. A practical working experience.
5. A technical training.

While all of these qualities are rarely at first combined in any one individual they can be quickly developed in most individuals of fair character and intelligence.

Do you think mining is a good career for a young man?

Yes, for a good man who is likely to develop a love for the work. It seems to me that today there is less over-supply of mining engineers than of doctors and lawyers.

You were at Juneau last summer; how were you impressed by the new enterprises for the mining of low-grade ore?

I found the mining and reduction methods lately introduced at Juneau most interesting and instructive. If the companies operating there at the high rate of wages prevailing can demonstrate that hard ore can be extracted from underground workings and reduced profitably when the yield is only $1 per ton, all

hard-rock mining men will recognize that a new mark for efficient mining work has been established.

LABOR IN MINING

*In this issue we publish an interview with a veteran of the profession, Henry C. Perkins, one of the engineers to achieve distinction in the period when Hamilton Smith and his friends were leaders in the business of gold mining. The mines in which he obtained his first experience, the Mariposa and the Almaden, are still active and the mention of them recalls the fact that many members of the profession served their apprenticeship at these famous properties. Mines are places where men as well as lodes are developed. New Almaden, more particularly, enabled Henry C. Perkins, Hennen Jennings, James B. Randol, Samuel B. Christy, Charles Butters, F. W. Bradley, and E. H. Benjamin to cut their wisdom teeth comparatively early in life. The quicksilver mines made money for their owners, but even if they had not done so they would have declared human dividends of a kind that money does not measure. The engineering work done at the North Bloomfield represented a notable achievement of the early days; it included several miles of bedrock-adit, big dams, and long pipe-lines; it was all done at a moderate cost and so well that it compares favorably with similar work in more recent years. It is pleasant to read the tribute paid by Mr. Perkins to Hamilton Smith. The latter was not only an engineer of fine acumen and high character but by his association with the Rothschilds he helped to introduce many young Americans to a wider career than California by itself could have offered. It must be remembered that 40 years ago the mining industry of the United States was of small dimensions compared with what it is now, and an ambitious engineer was lucky to obtain an opportunity abroad. The El Callao mine, in Venezuela, furnished experience to a large number besides Mr. Perkins and Hamilton Smith; for example, there were Hennen Jennings, Thomas Mein, George Webber, and W. L. Austin. None of them learned more from his sojourn there than did Mr. Perkins. He tells of two of the things he learned: that straight dealing is the best policy even with crooked people, and that human beings as workers are much

*Editorial in the 'Mining and Scientific Press' of May 19, 1917.

the same the world over if they are given a chance. He does not say much about the 'bluffs' that he 'called' while he was manager of the El Callao, but we have heard how mining inspectors, governors, even Guzmán Blanco himself, found it useless to blackmail or bulldoze the quiet young American who attended strictly to his business and assumed that others would do likewise. Nothing is so disconcerting to South American indirection as North American directness. Concerning the labor question he has more to say, and it is highly interesting. His experience in California, Venezuela, Mexico, South Africa, and Korea, among the districts in which he supervised mining operations, appears to have furnished him with decided ideas on the subject. We accept them as coming from a man wise rather than smart, sagacious more than merely clever. To the younger men we commend the advice to employ the indigenous population of a mining district, teaching them and treating them sympathetically, instead of importing labor from outside, more particularly workmen that are foreign in race and speech. To take high-priced American labor to Korea or Rhodesia, for example, instead of training and teaching the natives of either country, is the kind of mistake that has been made often both by British and American mine-managers. The disregard of this fundamental idea, of making the most use of the indigenous population, was the basic objection to the importation of Chinese into the Transvaal. The system of indenture succeeded up to a point, but that point was not passed, because the experiment was ended summarily; but if the Chinese had stayed the result would have been to give the Transvaal a hybrid population, and this would have delayed the development of the Kaffir as a mine-worker. Mr. Perkins put his idea to work in Korea, with notable success. He gives some comparative figures, suggesting that the rate of wages does not determine the cheapness of exploitation; on the contrary, the cheapest labor may prove the least economical. The comparison between the three mining districts of the Mysore, Korea, and the Rand is suggestive. To what extent a systematic effort has been made to educate the natives on the Kolar gold-field we do not know, but those Indian mines have been highly productive so long that any serious attempt to train the natives would have come to fruition by this time. In that district, as on the Rand, the employment of an excessive number of imported

white supervisers is a heavy item of cost, and goes far to discount the effect of paying low wages to run-of-mine labor.

The first appointment obtained by Mr. Perkins was as a book-keeper. It is evident that his early experience in book-keeping proved of the greatest usefulness, because it gave him a keen realization of the fact that the profit of mining is dependent as much upon diminution of cost as increase of yield. The system of accounts in use at a number of important mines on the Western slope is based on the book-keeping developed by Mr. Perkins at the North Bloomfield and Alaska Treadwell mines. His own success as a mining engineer is largely due to his ability to analyze figures. Thus did an early training bear fruit in after years. The reference to sampling in Korea touches upon a controversial point, namely, to what extent regular sampling with a moil and hammer can be accepted as a decisive factor in estimating the prospects of a mine. Mr. Perkins found gold in patches distributed irregularly in a group of quartz veins. The workings were unsystematic and the rich spots had been gouged. He found it safest to appraise the mines by making an estimate of the yield of gold per square foot of vein on the supposition that the ore, when worked on a larger scale, would be extracted continuously and without selection. The bigger operations that he had in mind could not be based upon the hunting of pockets or patches. His an important gold mine, the dividends aggregating $7,500,000, forecast has been justified. The Oriental Consolidated has proved His remarks on the Japanese occupation are friendly and fair. We infer that new American enterprise in Korea will not have as much chance in the future as in the past. In another part of the interview he expresses a decided opinion that any advance in mining economy must come through an intelligent and sympathetic study of labor conditions, of the relation between employer and employee. He warns us against the continued raising of wages, and suggests that the best results will be obtained by profit-sharing. This is good advice. In regard to the making of fortunes, speculation in shares, and publicity of company affairs, Mr. Perkins speaks with a sagacity that comes of keen observation and unbiased thinking. The older men have their own opinions and are not likely now to alter them, but we invite our younger readers to study the sayings of this distinguished veteran.

LOUIS D. RICKETTS

AN INTERVIEW

Dr. Ricketts, you are a New Englander by birth?

No; I am a Marylander. I was born at Elkton, in Cecil county, Maryland, in December 1859.

Were your people interested in mining in any way?

My father was the owner and editor of a country newspaper, and his family had been farmers in Cecil county since the 17th century. My mother was the daughter of a Scotch-Irish school-teacher, from the University of Belfast; he came over to this country with his wife and conducted a private school. My father died a few months after I was born. My mother had four children, and made up her mind she was going to educate them. She was in the South, the war came on, and she had to wait five years to settle up my father's estate. Then she moved up to Princeton and gave all of her children a higher education, for the time being at great personal sacrifice.

You went through the public schools and then to Princeton?

No; I had a defect of the eyes when I was born and did not learn to read until I was ten, so I received my preliminary education in private schools. You know our public-school system was not much to boast of in those days. I entered the John C. Green School of Science, in the College of New Jersey, now known as Princeton University.

When did you graduate?

I graduated in 1881, was awarded a fellowship in chemistry, and spent the following year in post-graduate study.

In chemistry?

Yes, in chemistry. About that time, Dr. McCosh, president of Princeton, had made a tour of the West and met a Princeton man named W. S. Ward, of Leadville. Ward offered a competitive fellowship in economic geology open to post-graduates. I was awarded this fellowship and went out to Leadville, in ac-

cordance with the terms of the fellowship, to study mining geology.

At that time Leadville was booming, was it not?

Leadville was in its glory, although there were no large individual mines, as measured by later standards; it consisted of a number of large ore deposits chopped up into small holdings. After I had completed my studies at Leadville, which lasted for four or five months, I returned to Princeton in the fall of 1882. wrote my thesis on the ores of Leadville, for a doctorate, and was granted a degree of D.Sc., 'in course', at Princeton.

What does "in course" mean?

It means that you take the degree as a result of examination after two years of post-graduate study; it is not an honorary degree.

How did you pass from chemistry to mining?

While I was trained as a chemist, I had had a little experience in surveying. At the end of my post-graduate course, I was offered the choice between teaching at Princeton and going to work as a surveyor for the Morning and Evening Star mines. which were under the management of Mr. Ward; and I remember particularly the advice that was given to me by my dear friend, Professor Henry B. Cornwall of Princeton. He told me that, although he would be glad to have me as his assistant, he knew that there were great mountain systems in the West, that Gilpin county had been developed, and that now Leadville had come, and that he thought there surely would be a great development of mines in the mountains of the West, and he believed that, if he were I, he would take the chances and go out and grow up with the West.

He must have been a man of some imagination?

I should hardly say that; he had wonderful common sense.

When did you go to Leadville as surveyor?

I went there in July 1883, and remained as surveyor of the Morning and Evening Star mines until the spring of 1885. At that time I was given the opportunity to go to Silverton, to take charge of the development of some mining claims on Galena

mountain and in Poughkeepsie gulch. They were owned by the Gipsy Maid Mining Co. of New York City. Slight development showed that these prospects were valueless, so, in the fall of 1886, I recommended that they be closed-down, and was out of a job.

I remember meeting you at the Morning Star mine at Leadville in the fall of '86, so I presume you returned to Leadville.

Yes, I returned to Leadville and entered into general practice as a surveyor and remained there until the spring of 1887, when I was offered the position of Geologist of Wyoming, which I accepted.

How did it happen that you were offered this appointment?

Wyoming was then a territory, and President Cleveland had appointed Thomas Moonlight, of Kansas, as Governor. The position of Geologist of the Territory was vacant, and he, not being a mining man, requested the Governor of Colorado to recommend a man.

Was Alva Adams the Governor of Colorado at that time?

Yes; Governor Adams referred the matter to Fred Buckley, of Leadville, who recommended me for the position.

You liked your work in Wyoming?

Yes, I liked it very much. I was inexperienced and was really not much of a geologist, but I liked mining and kindred subjects. I worked not only officially and published various reports, but I was also encouraged to, and did, take outside consulting work within Wyoming, and during my time there had experience in railroad reconnaissance work for the Union Pacific and Burlington railroads.

How long did you remain there?

In 1889, I think it was, Wyoming became a State, and Francis E. Warrren was elected Governor. He is now U. S. Senator. He re-appointed me as Geologist, and I remained until the fall of 1890, when I resigned to take a position in the South-West with Dr. James Douglas.

How did you first meet Douglas?

In the summer of 1881 I joined a college friend in surveying his father's country place on the Hudson river. Eight years

afterward, my friend and his father recommended me to William E. Dodge as a capable young man, and Mr. Dodge spoke of me to Dr. Douglas, who sent for me and, after taking me on a trip to Arizona, employed me as an examining engineer. That was in the fall of 1890. I spent some time in studying the coalfields of northern Sonora and those on the Apache Indian reservation in Gila county, Arizona. These coalfields were worthless, but Dr. Douglas was very anxious to find coal and sent me back repeatedly to examine them. I remember that he told me that the transmission of electric power was going to become vastly important, and that if I could find even an inferior grade of coal that would burn at the pit he believed that we should acquire it, because, with the development of electric transmission, it would be of great service to the Arizona mines, on account of the great distance that coal had to be hauled to the South-West. At that time Dr. Douglas had purchased the Copper Basin mines, near Prescott, and was installing a small leaching-plant to test the Hunt and Douglas process. For about a year I was in charge of this enterprise. The process was sound theoretically, but metallurgically it was a failure, owing to the mechanical imperfections of the plant and the losses by volatilization. Apparently, oxichlorides were formed in large quantities, which could not be removed by washing, and caused great loss by volatilization when the impure sub-oxide of copper was smelted.

What did you do next?

About the close of 1892 I left Dr. Douglas and worked on my own account in Colorado and Wyoming as a consulting engineer. I also mined on my own account in the Silverton district, making trips to the South-West for Dr. Douglas at intervals. At Silverton I obtained the most valuable experience of my life. I took a lease, jointly with friends, on the Sierra Madre mine on Galena mountain. We struck a pocket of 10-oz. gold ore and made a little money. This gave us courage to put up a mill before the mine was sufficiently developed. The result was that in 1895 I 'went broke' and had to borrow money to pay my debts. What seemed then a disaster proved to be a blessing, because it taught me two things: first, that it is necessary to develop a property before capital expenditures are made for a plant; second, that it is unwise to try to operate a low-grade mine without sufficient capital.

So the rich pocket happened to be—

It proved to be superficial, and the larger bodies of lower-grade ore that we relied upon were likewise superficial.

You will agree with me, Dr. Ricketts, probably, that a little experience in leasing is an excellent experience for a young engineer, by teaching him that the purpose of mining is to make money; in other words, it brings him face to face with the economics of the industry.

Yes. In those days, I think, it was advisable that a young man should either lease or otherwise go into mining on his own account, in order to gain a concrete idea of the responsibility of mining, and the same thing, I think, holds good today, except that there are not as many opportunities for leasing and mining in a small way.

Then would you expect a graduate from a mining-school to go to work underground? As you know, it has always been a question whether educated young men should begin their careers by doing manual work.

I think that depends very much upon the individual. Manual work gives him an opportunity to know the viewpoint of the workman; and, if in the future he is called upon to handle men, such an experience is immensely valuable to him. This is merely an opinion, because I have not worked either as a miner or a smelter-hand; but I have always regretted that I did not have a little experience of the kind, in order that I might be closer to the worker's viewpoint.

You were saying that your mining near Silverton left you 'broke'. How did you extricate yourself?

Dr. Douglas employed me as his assistant. I had gone to work for him in the previous winter of 1895. That winter I took a pack-train and made an extensive investigation of the resources of northern Sonora. Among other places, I went to Nacozari. At that time the Guggenheims had bounded the Fortuna and Pilares mines, and were doing development work. They were operating a small silver-mill that had nothing but a crusher, rolls, and jigs, and they were packing concentrating ore from the Pilares six miles down the mountain, treating it at this mill, and roasting the concentrate in a Pearce turret-roaster, using

oak as fuel. The calcine was then briquetted and smelted to a matte in a 36-in. water-jacketed furnace. The smelter was running intermittently, of course; the ore that they were mining contained about 6% copper; and the smelter was 90 miles from a railway, so I assumed that the work was being done in order to obtain information for a proper metallurgical plant. It transpired, I believe, that the owners expected to profit from the operation, and when they met with a decided loss they became discouraged. I was tremendously impressed with the Pilares mine and thought it a great property, so, when later the Guggenheims represented to Dr. Douglas that they were not copper miners and offered to turn the property over to him if he would assume the bonded debt, which was small, and pay them a very reasonable compensation in case he developed the property successfully, I advised him to make the deal. Dr. Douglas visited the property in the fall of 1896 and purchased it for himself and his associates of Phelps, Dodge & Company.

So you became the godfather of Nacozari?

Yes. I succeeded Mr. Danforth as general manager, developed the mine, designed and built a concentrator and smelter. At the same time I designed and built a 400-ton concentrator, a large mill in those days, for the Detroit Copper Mining Co., the financial interest in which was purchased by Phelps, Dodge & Company in 1897. In designing this mill I met Thomas Robins, who had but recently formed the Robins Belt Conveying Co., and as a result I installed one of his 36-in. and two of his 18-in. belt-conveyors at Morenci. This installation, as far as I know, was the first of its kind in the Rocky Mountain region. At this time, in 1897 or '98, I forget which, I made a trip through the North-West to study milling practice. At Salt Lake City I met L. S. Gillette, who founded the Minneapolis Structural Steel Co., and he convinced me of the superiority of steel over wood construction for mills and smelters. As a result of this conference, I introduced all-steel construction in the South-West. Since that date I have directed work consuming many tens of thousands of tons of structural steel. H. A. Fitch, a young designing engineer and salesman in the employ of Gillette, began to come to the South-West a few years afterward. He aided me greatly in designing and made many valuable suggestions. We became warm

friends and later in 1906 we became associated in the structural-steel business, which he wished to enter. While I knew nothing of the business, I knew the man. He has become highly successful after a long and hard pull.

In the construction of the Nacozari plant, my old friend, John Langton, designed the transmission machinery and the power-plant, and supervised its construction. This plant was novel in that it consisted of seven 250-hp. Crossley gas-engines, belted to direct-current generators, the motive power for the smelter and concentrator machinery being furnished from this central plant. Mr. Langton installed a gas-producing plant of two Loomis-Pettibone producers. At that time Nacozari was 90 miles from a railroad, and as there was abundant oak in the vicinity, Mr. Langton was of the opinion that he could generate a producer-gas from wood, which was done successfully for several years.

Langton died recently, did he not?

Yes, Langton died of pneumonia, in February 1920, at Inspiration. He was a man of fine personality. He had a tremendous fund of general information, was a good critic of books and plays, and had a profound knowledge of the theory of his profession, and as a consulting mechanical engineer, especially on power and the transmission of power, he did splendid and valuable work. As a mechanical engineer he was identified with the development of the great copper industry of the South-West.

Returning to Nacozari, did you remain there long?

As the Nacozari mines developed, it became evident that a railroad was abundantly justified; so the railroad was completed, though not so soon as I advocated. After the plant had been completed and the success of the mine demonstrated, I was transferred by Dr. Douglas to other work, and was succeeded by his son, James S. Douglas, who managed the property for a number of years very successfully. When the railroad was completed to Nacozari, the steam-turbine had been sufficiently developed, and coal was then obtainable as fuel, whereupon Langton designed a turbine plant to replace the Crossley engines, which had become antiquated. This was one of the first turbine plants in the West, I think. At the same time H. Kenyon Burch designed

a much larger concentrator to meet the requirements of the mine, this was constructed under the supervision of Mr. Douglas. In the meantime, a reduction works had been built by the Copper Queen company at Douglas, the Nacozari smelter was abandoned, and the concentrate shipped to Douglas for treatment. The Nacozari property continues to be a great producer and has proved enormously valuable.

What was your next task after you left Nacozari?

I took a rest and went to Europe. On my return I was sent to Globe. In 1890 and succeeding years Dr. Douglas had acquired the Old Buffalo mine, the Hoosier property, and other claims at Globe, which were brought together under the name of the United Globe mines. The exploratory work on these claims, for the time being, was disappointing, and for several years the development of this venture was delayed. In the meantime, the Old Dominion mine had been acquired by the Lewisohn-Bigelow interests, and after a somewhat varied career the control was taken over by a group of stockholders under the leadership of Charles S. Smith. The possibilities of this great mine had not been recognized. It had been worked exclusively for high-grade ore; the low-grade material had not received attention, nor had the mine, which had developed large quantities of water, been equipped with the proper machinery. As a consequence, the company was nearly bankrupt. In 1903 a consolidation was effected between the Old Dominion and the United Globe mines, through which the then Phelps-Dodge interests assumed control. I was put in charge as manager, and completed the construction work that had already been started by the Old Dominion company under the supervision of Frederic W. Hoar. During the three years following my assumption of the management, I designed and built a concentrator and completed the smelter, but the main task was to re-open the mine. For years the workings had followed the main fault-fractures along which the ore deposits occurred; here the ground was soft and the openings could not be maintained; the foot-wall of the ore deposit, however, which was of diorite, was firm and solid, and an entire new set of workings had to be opened up in the foot-wall country on the six active levels in order to obviate prohibitive maintenance costs and avoid ruinous delays. The ore-bearing ground was attacked through numerous short cross-cuts.

Did you have any metallurgical problem?

Yes, several important problems. When I assumed control of the Old Dominion a young man who had worked at Aguas Calientes for the Guggenheims was the metallurgist; and this was my first meeting with Charles S. Shelby. In the years that followed I was associated with him intimately. Shelby was somewhat of a dreamer, but had a wonderfully suggestive mind, and was, I believe, one of our metallurgical geniuses. As often happens, his mind was so active in suggestion that it was difficult for him to separate the commercially feasible plans from the impracticable ones. Shelby left me finally to go to Cerro de Pasco. He did, I am told, invaluable work for that company; and, I believe, by his unfortunate death in an automobile accident, the metallurgical profession was deprived of one of its most valuable members.

During the years that you were at Globe was your attention ever called to the low-grade deposits on which the success of the Miami and Inspiration companies is founded?

No; I knew of the claims, but I had no comprehension of their latent possibilities at that time.

Did you make any changes at the smelter?

After the concentrator was completed, it became evident to me that the blast-furnaces at the Old Dominion ought to be supplemented by a reverberatory plant, because the fine concentrate tended to blow out of the blast-furnace about as fast as it was put in, and the mechanical loss of copper was excessive. At first Dr. Douglas was unwilling to authorize me to proceed with this heavy expenditure; however, he gave his consent finally, but about that time I left the employ of Phelps, Dodge & Company, and the furnace was never built. It is interesting to speculate on what the result might have been had a reverberatory plant been erected by the Old Dominion company, for the reason that in that event undoubtedly it would have contracted to smelt the Miami concentrates and thus would have gained knowledge of latent possibilities that would have been invaluable. Such a development in metallurgical practice would have revealed the potentialities of the Miami district outside the Miami Copper Co.'s property.

You are referring now to a period before the Inspiration Consolidated Copper Co. was organized; do you refer to the group of small mines such as the Black Warrior, Keystone, and Live Oak?

I am referring to the groups of claims that have since become the property of the Inspiration Consolidated Copper Company.

You had a lot of water in the Old Dominion?

We had a lot of water. Previous to my coming they had purchased a number of large Prescott direct-acting steam-pumps. These pumps were flagrantly extravagant in the use of steam, and proved a source of great expense. In spite of the fact that the company had just purchased these pumps, I made up my mind that, with the great quantities of water to be handled, a higher-class pump should be used; accordingly I arranged to put in high-pressure boilers, and purchased four triple-expansion duplex crank-and-flywheel pumping-engines, each of 1000 gallons capacity, from the Nordberg Manufacturing Co. These pumps were delivered, but not installed, during my regime as manager of the Old Dominion. I understand that when they were installed some years later they reduced the pumping expense about $10,000 per month.

How much water were you pumping?

The amount of water varied, but at that time it averaged 3½ million gallons per day from a depth of about 800 feet.

What fuel did you use?

Oil. That reminds me; it was during this period that Dr. Douglas purchased the El Paso & Northeastern Railway in behalf of the Phelps-Dodge interests. At the same time the same interests purchased the Dawson Fuel Co. The coal-washer at Dawson, New Mexico, was inefficient, and it was evident that the slack or crushed run-of-mine coal had to be washed in order to produce a superior grade of coal for coking. At this time I went to Europe to study the progress that was being made in England and Germany in washing coking-coal, and on my return in 1905 I designed a coal-washing plant in conjunction with Thomas H. O'Brien, who afterward became manager for the Dawson Fuel Co. and is now general manager for the Inspiration Consolidated Copper Co. This washing plant was a new depar-

ture in the coal-mining industry, and I think most of the good people of Colorado and New Mexico thought that I was mildly insane in building it, because I introduced steel construction and reinforced concrete work, building a substantial plant, instead of the usual ramshackle wooden affair that requires excessive repairs and a maximum labor cost. Although the plant became antiquated in time, it was very successful; it did clean work at a minimum cost, and produced good coke.

Do you remember any figures of cost?

No; it is too far back. All I remember is the costs were as estimated, the coal was cleaner, and the saving of coal was greatly increased. For the construction of this plant I recommended Horton Jones to Mr. O'Brien as construction engineer. He was a genius at this kind of work. Later he did splendid work for me in the construction of the Arizona Copper Co.'s smelter, and is now assistant manager, I believe, for the International Nickel Co. at Sudbury.

It is interesting to note how men like Messrs. O'Brien and Jones have been able to apply their knowledge of engineering and of human nature with equal success in the production of one mineral as of another, although usually a colliery experience is not supposed to be applicable to metal mining.

I think that is a mistaken idea. The different kinds of mining and metallurgy, after all, are parts of one great art. Most of the advances made in any branch of mining or metallurgical industry are linked to the treatment of products in other branches. For instance, the only difference between washing coal and concentrating ore by gravity was that, in the one case, you saved the heavy material and threw away the light; in the other, the reverse; but the principles of gravity concentration applied to both, and there is every reason to believe that the engineer with extended experience in ore-dressing can bring good ideas into coal-dressing. The same reasoning applies generally to handling and transporting materials.

Obviously, your association with Douglas was one of the most important factors in your career.

Yes, indeed. It gave me a wide variety of experience. My

close association with him was undoubtedly of personal benefit. The point of Dr. Douglas's character that stands out in my mind was his imagination. He had great insight, and in conjunction with William E. Dodge and D. Willis James, who had the shrewdest financial sense, he built up a great and wonderful enterprise. I want to lay emphasis on his remarkable sagacity in foreseeing the latent possibilities and resources of the South-West, and upon his untiring efforts to improve metallurgical processes.

When did you begin your connection with Cananea?

While I was at Globe I acted as consulting engineer for the Greene Consolidated Copper Co. in so far as their concentrating operations were concerned. I had supervision of the remodeling of their first concentrator and the building of a new one, and in that connection I employed David Cole, who at that time was the superintendent of a small mill at Aspen, Colorado. I found Mr. Cole a very competent young man, and, as is usually the case when a man comes from one branch of industry to another, he introduced new ideas effectively.

Did you then assume the management of the Greene Consolidated?

No; I did not. I was offered the management of the Greene Consolidated, but at that time was not satisfied that it could be properly financed, and thought it better not to accept. During this time and previous to this time I had become acquainted with William C. Greene. I admired the many good points in his character. He was always loyal and generous to his friends, and responsive to any sentimental tie or call from them. I owed to him my first opportunity to make any considerable sum of money, as he let me have 5000 shares of stock in the America Mining Co., at Cananea. Subsequently I disposed of sufficient of this stock to pay its cost to me and invested the balance in the Greene-Cananea Copper Co. At the end of 1906 the Greene-Cananea Copper Co. was formed, and control of its direction was assumed by the present board of directors. I was offered, and accepted, the position of general manager, taking active charge in March 1907.

You speak of the present control. Does that mean the Anaconda company?

No, but Anaconda and Greene-Cananea have many common shareholders and the same executive direction.

So you then formed a new and very important professional connection?

Yes, I formed a very important professional connection at that time and also became associated with some splendid men. My direct superior in New York was W. D. Thornton, who since that date has been my constant friend and adviser, and we have worked together in a most harmonious way. Also when I went to Cananea I found a splendid set of men on the general staff. My old friend, James H. Kirk, was superintendent at the mines, and Charles S. Shelby had charge of the smelter, David Cole had the concentrator, Tindall Evans the traffic and purchasing department, and George Young was the secretary of the company. All that these able men needed was encouragement and help, and, after a general plan of work had been laid out, for them, to be shown how to work together. I made no changes in the general staff except that I reduced it somewhat, and all, except Shelby, continued with me during the major portion of the time I was in active management of the property.

Were there any special technical problems that you had to solve during this period?

Yes. The mines were under-developed and required a great deal of planning and a great deal of money spent in order to centralize, provide new outlets, and open up further ore-reserves. The smelter was an impossible structure and, aside from the bedding plant, had to be completely re-constructed. Steps had to be taken to induce the railways to give Cananea at least approximately the rates that neighboring points in Arizona were enjoying. It was just after I took charge of this property that the panic of 1907 came, and in order to be successful it was apparent that the operating costs at Cananea had to be reduced about 9 cents per pound of copper. This was done, but it took all of the planning and hard work of the entire organization to accomplish it.

What was your next professional connection?

While I was at Cananea I was consulted on various matters by the Anaconda interests. I also undertook to act for three years as consulting engineer to the Arizona Copper Co. During that time I built its new reduction works at Clifton. I also be-

came consulting engineer for the Calumet & Arizona Mining Co. at Bisbee. It happened that the old Calumet & Arizona Mining Co. and the Superior & Pittsburg Copper Co., which were affiliated in ownership, wished to consolidate, or, rather, the latter company wished to go out of business and sell its physical properties to the Calumet & Arizona Mining Co. for stock in that company. James S. Douglas and I were employed to recommend a proper basis for consolidation. Following this work, I was employed as consulting engineer by this company, and in association with John C. Greenway, its general manager, built the new smelting works at Douglas in 1911 and 1912. In connection with the construction of these smelters, we necessarily had to have assistants, so we employed C. H. Repath and A. G. McGregor, who designed the Calumet & Arizona smelter under our direction. Later Mr. Repath retired from the firm, but Mr. McGregor became associated with me in the design of the Arizona Copper Co.'s smelter and the smelting works of the International Smelting Co. at Miami. He has developed into a mechanical engineer of the first rank. Since that time Mr. McGregor has gone into practice on his own account, and has recently designed the United Verde Extension smelter and the new smelter of the Cerro de Pasco Mining Co. in Peru, with which operations I have had no connection.

In designing these smelters did you introduce any new features?

No, I cannot say that I originated any really new features in the new smelters in Arizona except that progress was made and careful observation was given to work that was being done elsewhere, and an attempt was made to employ, as far as possible, the best standard practice. As a matter of fact it is rather dangerous to introduce new features in new plants; new features should usually be introduced in established works. I did select new ideas and decided on processes. Gmahling and Shelby had developed the idea of fettling through ports in the roof of a reverberatory, and this idea was carried forward. In the meantime David H. Browne, at Sudbury, had developed the idea of side-feeding the charge and doing away with fettling by protecting the walls of the furnace with the charge itself. These ideas were adopted and developed, and since hand-fettling was no longer necessary and it was therefore practicable to widen the furnaces, I decided it was safe to use larger units, and so I made

the first departure in the Arizona Copper Co.'s plant by increasing the width of the reverberatory furnace beyond the old maximum of 19 ft. The latest furnace that I have erected at the International plant is 25 feet wide.

While at Cananea did you smelt any custom ore?

Yes; I had become convinced that, with the exceptionally rich concentrate Miami was able to produce, a high saving could be made, and that the treatment of the concentrate would lead to the building of a smelter at Miami, basing my faith on the belief that great mechanical losses could be avoided by proper construction and by the adoption of Dr. Cottrell's invention, which was then attracting attention.

How did you treat the Miami concentrate at Cananea?

I had to use a temporary expedient. Part of it was treated in the reverberatory furnace, but a large proportion was dried and blown with the blast through the tuyeres of the converter. In this connection, I built good hoods and an ample dust-chamber for the converters, in order to avoid mechanical loss. Of course, the concentrate could only be blown in while the converter was turned up. Later, a contract was made with the old Inspiration company for the treatment of its concentrate, which positively assured the building of a new smelter at Miami. This was done in 1910 or 1911. In this year my principals purchased the Live Oak property and later on it was consolidated with the Inspiration as the Inspiration Consolidated Copper Company.

By your "principals" you mean, I presume, what is usually called the Anaconda interests? Also I would ask whether W. B. Thompson was not in control of the old Inspiration company?

Yes; W. B. Thompson was in control of the old Inspiration company and remained nominally as president of the Inspiration Consolidated for a time. The management was put under my direction by Thornton. The important question then arose of selecting a general manager; I chose Charles E. Mills for this position, because I considered him the best man in America to undertake the development of a low-grade copper mine and the construction of great works in conjunction therewith. The development of the Inspiration Consolidated was an exceedingly

interesting problem and required great faith on the part of the directors and the shareholders. The engineers had faith, and believed that they could make the property a very valuable one, but the board of directors had to provide about $13,000,000 of gold coin to justify this opinion and wait until after this vast sum was spent before they obtained concrete results. In this connection, I think that attention should be brought to the necessity of new enterprises involving risk being assured a high return in case they are successful; for the reason that, if expansion is desired, then encouragement has to be given to the expenditure of money, based on the opinion of competent engineers, whose opinion cannot be confirmed until after the money is spent.

What were your metallurgical plans?

Our original intention was to build a wet-concentration plant. Mr. Mills employed H. Kenyon Burch as engineer for the designing of a new concentrator; a mill of 10,000 tons capacity was designed, and the steel structure actually erected. During the erection of this building the Minerals Separation people brought to our attention certain tests that they had made on Inspiration ore.

These tests were made by E. H. Nutter in San Francisco?

I believe they were. It was decided, therefore, in spite of heavy interest charges, to delay construction, and arrangements were made for the Minerals Separation company to furnish us with a 50-ton testing-plant, and we conducted experiments with this plant for some months.

Jointly with them?

With their assistance and advice, Yes. The saving was so high and results generally were so encouraging that Mr. Mills then erected a 500-ton testing-plant and tried the froth-agitation process on a scale that he estimated at the time as being equal to the capacity of a single unit in his new mill. At the same time he conducted tests on grinding machinery and pneumatic flotation machines. Dr. Rudolf Gahl was employed by him in these investigations, and developed a flotation-cell that is now in use in all but two sections of the new mill. The tests were so thoroughly successful that froth-flotation was adopted. Another important feature was the adoption of a steel-ball mill for fine grinding.

I believe this was really one of the large departures in milling. The consequence of the adoption of flotation and the use of the Marcy ball-mill, which requires very little floor-space, was that our mill, in a building originally designed for a 10,000-ton plant, was able to treat 18,000 tons per day.

Do you believe that the Minerals Separation people are entitled to the royalties they demand?

I don't care to enter into a controversy with which I am in no way connected. I will say that I believe that the Minerals Separation people brought their process to our attention and that, whether their patents are valid or not, they rendered to us at least a great professional service, and I believe that the arrangements that we have with them are equitable and reasonable under the conditions, and they certainly bring to both sides peace of mind.

Of course, you have a contract far more favorable than is granted to most mining companies?

As to that I have nothing to say. In conjunction with the development of the mine and concentrator at the Inspiration, the International Smelting Co. had to build a smelter in which to treat the Miami and Inspiration concentrates. This plant, as already stated, was designed by McGregor under my direction. L. R. Wallace was superintendent of construction and operated it for several years most successfully. Wallace was the superintendent of the smelting works of the Detroit Copper Co. for many years before he undertook this work. He is an able manager and a metallurgist of the first rank. I sent him from this plant to Chile as general manager for the Andes Copper Co.; and this position he holds still. On account of the fineness of the flotation product it was imperative to avoid mechanical losses as far as possible. For this reason I purchased from the Western Precipitation Co. the right to use the Cottrell process at this plant, in so far as the saving of solid particles was concerned. Exceedingly strong and massive calcining-furnaces were built on account of the tenacity of the wet concentrate, and special methods were adopted for the avoidance of dust in handling calcine from the hoppers and to the furnaces. These have been improved since by L. O. Howard, the superintendent, so that remarkably little loss is sustained in the operation of charging the furnaces, and

the calcine-house and the reverberatory feed-floor are as clean as any portion of the smelter.

The treatment of flotation concentrates has given a good deal of trouble to smelter-men, who probably did not at first realize the true character of the product. I would like to ask you whether you would advise the use of some drying machine between the filter and the reverberatory furnace?

No; as a rule there is some table-concentrate produced in a flotation mill; this helps by admixture to make the flotation concentrate more porous, and reduces the average moisture. I believe that, if sufficient care is taken, the concentrate should not be sloppy, and, of course, it is always advisable in a metallurgical process 'to take one bite at the cherry'.

In other words, avoid a multiplicity of operations?

Yes. The Cottrell process was applied, of course, to the calcining furnaces and was also applied to all converter smoke; but it was not applied to the reverberatory furnace smoke, in spite of the fact that we feed these furnaces practically continuously and with a dry pre-heated charge. It is true, there is some dust-loss from our furnaces, but the best test that we could make indicates that it would scarcely pay to go to the great expense of treating the large volume of reverberatory gas in the Cottrell plant. So far as we can determine, the mechancial loss—that is, all the loss apart from the slag—at this plant amounts to about 0.8% of the total copper content. When we first started the plant, we found with this class of material—flotation concentrate—there was a tendency to liquation in the reverberatory furnace, that is, the iron oxide would tend to combine with a part only of the silica, and liquate out with the matte, leaving a silicious putty-like mass floating on the charge, which caused the copper content of the slag to be abnormally high. Mr. Howard has adopted the method of tapping his reverberatory slags on a line above the matte but below this crust, and finds that after a certain amount of the crust has accumulated it fluxes off at the bottom about as fast as it accumulates on top. Careful tests extending over 18 months have shown that by this method he has saved about 50 tons of copper per month.

Won't you say something about the New Cornelia enterprise?

In 1911, John C. Greenway took an option on the controlling interest of the stock of the New Cornelia Copper Co. on behalf of the Calumet & Arizona Mining Co., and started drilling operations at Ajo, Arizona. The results of his drilling operations indicated about 11 million tons of oxidized copper-bearing monzonite, averaging about 1½% copper, and some 40 million tons of sulphide material of about the same grade. Later on, through cash and stock purchases, the Ajo Consolidated Copper Co.'s physical property was acquired, bringing the tonnage of oxidized ore to about 14 million tons, and, with additional drilling, increasing the sulphide tonnage to something over 50 million tons, with further possibilities.

From whom was the Ajo Consolidated property purchased?

From James Phillips, Jr. The ore is a granitic rock, usually called monzonite-porphyry, containing copper minerals associated with little, if any, pyrite, but with some magnetite. As is usual in deposits deficient in pyrite, the copper did not migrate, but was oxidized *in situ*. There is scarcely any zone of secondary enrichment between the oxides and sulphide, and this secondary zone is very thin. It was evident that if the oxidized material could not be treated commercially it would be simply an overburden, which would have to be mined and thrown away, whereas if it could be treated commercially it at once became an asset instead of a liability; an open-pit mine with practically no overburden could be started, and ore would be at hand with the first rock that the steam-shovel lifted.

The decision to treat the orebody by a leaching process require some courage.

Like the new mines that have come forward through the improvement in metallurgical process, the outcome was based upon the opinion of the engineers associated with the project. This point was thoroughly realized by Colonel Greenway and myself, and we spent several years studying the subject in conjunction with competent engineers. In this connection, we consulted Stuart Croasdale, F. L. Antisell, and the firm of Pope & Hahn. Our own engineers included James A. Potter and Henry A. Tobelmann. The tests originally were made at Douglas on small amounts of ore brought from Ajo. Later, a one-

ton plant was erected at Ajo, followed by a 40-ton unit. The results were so encouraging that we jumped from the 40-ton unit to the 5000-ton plant that is now in successful operation. Once the process was decided upon, the work of construction proceeded, and Mr. McGregor was employed to design the plant under the direction of Colonel Greenway and myself. The process is simple. We found that a high extraction could be made on the oxidized ore with a dilute solution of sulphuric acid. We found that, although considerable amounts of alumina and iron oxides were dissolved, the former salt gave little trouble in electrolytic precipitation, and the latter could be controlled through the use of sulphurous acid. In consequence, we decided to recover the copper in major part electrolytically, reducing the ferric sulphate to ferrous sulphate by subjecting the solution from the leaching vats to the action of sulphurous gas before it went to the tank-house for treatment.

In what way is the SO_2 reduction applied?

The entire process has been described technically by Tobelmann and Potter. The chief feature is the establishment of an enormous surface of contact between the liquid and the gas. Necessarily, as the iron and alumina accumulate, a portion of the solution has to be discarded. A part of the copper from this discard is then recovered electrolytically, and the remainder by precipitation on scrap-iron. Most of the cement copper thus produced is re-dissolved with a corresponding reduction of a portion of the ferric iron.

In other words, you use the cement copper partly to reduce the ferric sulphate?

Yes. The plant has worked successfully, and has treated several million tons of ore, producing copper at a low cost.

Did you draw upon the experience of others?

No, I cannot say that we did. We used whatever information we could get, but there is absolutely nothing in common between our work and that at Rio Tinto, for example; and the splendid work of Cappelen Smith at Chuquicamata did not apply to our ores or conditions.

I understand that your associates have become owners of an oilfield in California?

Two companies with which I am connected have purchased the old Peerless oil property in the Kern River field in California and are operating it under the name of the Arizona Oil Co. This purchase was not made because the companies wished to enter into a new industry. They considered the property well worth the purchase-price, but, still more important, its possession protected their fuel supply. At present the oil for the copper industry of Arizona is coming almost exclusively from Tampico, and the oil that the Arizona Oil Co. produces is sold on the market, but with an agreement, any time we wish, that Inspiration and International will be furnished with California fuel-oil up to total requirements.

This means that, in case of a revolution in Mexico, you would have not only the supply from your own property, but the oil company would also provide you with whatever more was necessary?

Yes, within reasonable limits. Two things are now coming up, of exceeding importance. One of them is the assurance of a fuel-supply, because, not only is the cost of coal nowadays tremendous, but the Trinidad and Raton coals are not well adapted to reverberatory work. I feel that the cutting off of our oil-supply in the South-West might force the development of methods other than the fire process for the reduction of copper. We can probably obtain our power from other sources than coal or oil—that is, from streams—but I am inclined to believe it is possible that, rather than operate with high-priced impure coking-coals as smelting-fuel, we would develop wet methods for the treatment of sulphide and mixed ores, with the direct production of refined copper. The other important point is the necessity of decreasing the present freight-rates. I have recently had a study made of what the increase in freight means to four of the large mines with which I am connected, and it shows that if operating somewhat under normal capacity these mines would be now paying out in direct freight $3,500,000 a year more than they would have paid if 1916 rates prevailed. This amounts to an increase in direct freight charges alone of about 1½c. per pound of copper. In consultation with other mine operators in the South-West I find they estimate about the same increased cost due to increased freight charges. Under normal conditions

the South-West, including New Mexico, Arizona, and northern Sonora, can produce about 800.000,000 lb. of copper, which means an increase in direct freight paid of about $12,000,000 per annum, or 77% for the entire district. This has nothing to do with increased costs of labor or supplies. Recently there has been a tendency toward some reduction in freight, and it would appear that shortly a rate of $16.50 on copper will go into effect, being a reduction from a maximum of $22 per ton, but this is still some 65% higher than the pre-war rate. The railroads are in a very difficult position; their business has been disorganized, and operating expenses are far higher than they were formerly; unless freight rates can be reduced, either the public will have to pay a sufficient price for copper to absorb the increased freight, which it does not show any inclination now to do, or the mines must continue idle, as they now are, or a new outlet to tidewater must be provided.

DR. RICKETTS OF ARIZONA

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*At the time of the Panama-Pacific Exposition in San Francisco, six years ago, the directors requested that each State should select its most useful citizen for the award of a medal. Louis D. Ricketts was designated the favorite son of Arizona. It was a fair and reasonable selection, for Dr. Ricketts has been identified with the mining industry of Arizona in a very special way. In this issue we publish an interview with him, in the course of which he has been compelled to tell the story of his professional career. We say "compelled" advisedly, for whereas he was willing to play golf with the Editor and even to dine with him, he demurred to an interview until we exercised compulsion. It was done in this way. When he declined the honor, as we deemed it to be, we asked him if in the course of his career he had not been assisted, from time to time, by capable and loyal younger men. "Yes, indeed", he replied. "Then", we retorted, "here is your chance to say so in print, where the acknowledgment means something." That settled it. "You have me." The interview was started forthwith. We commend it to our readers as the story

*Editorial in the 'Mining and Scientific Press' of October 1, 1921.

of a remarkable career. Dr. Ricketts—for the prefix has clung to him all these years—had the misfortune of losing his father prematurely, but his mother was an exceptional woman, and enabled him to make a good start. To her tenacity and courage, under adverse conditions, he owed his education. Then, in the nick of time, came the fellowship at Princeton that gave him a special knowledge of economic geology and his doctorate in science. The benefactor who founded the fellowship deserves kindly mention, which it is the more pleasant to make because many of us knew W. S. Ward either at Leadville or at Denver, where he was engaged first in mining and then in real-estate speculation. He himself had taken a post-graduate course at Oxford, and in turn, when he had made a little money, used some of it to create opportunities for the younger Princeton alumni by founding the fellowship. He passed the torch; let that be his epitaph. Our subject started his active career as a surveyor at Leadville and then became geologist to the Territory and State of Wyoming. The critical event of his younger years was the contact with Dr. Douglas. How wide has been the influence of James Douglas and how many are the men eager to acknowledge their debt to him! His memory is kept warm by the kind deeds he did to his juniors in the profession. To Dr. Ricketts the acquaintance and later the friendship with Douglas meant the opening of the doors of opportunity and the stimulating association with a big man. Before, however, he got into his stride, as it were, Dr. Ricketts went through the experience of losing money in a mine and becoming 'broke'. That was a useful experience, for it gave him a keen appreciation of the part that money plays in the winning of ore, and inoculated him with the basic concept that mining is only digging unless done at a profit. The contact with the Guggenheims at the Pilares mine is interesting. Evidently at that time the Swiss-American captains of industry now so prominent in mining and smelting were timid of engaging in copper mining, in which since they have scored so successfully. At the Pilares, Dr. Ricketts built his first concentrator and first smelter. That was 25 years ago. Many are the mills and smelters that he has designed and constructed since then. Indeed his later life is crowded with achievements of this kind. He has been an extremely busy man.

A veteran engineer remarked to us a few days ago: "Ricketts was as hard a worker as Hamilton Smith and worked in just that nervous way, not wasting a minute, day and night—early in the day and late at night". This association of names is appropriate; Hamilton Smith is only a name to the younger generation, but he was the undoubted leader of the mining profession forty years ago. That reminds us that our interlocutor possessed a copy of 'The Ores of Leadville and their mode of occurrence as illustrated in the Morning and Evening Star mines, by Louis D. Ricketts, B. S., Ward Fellow in Economic Geology of the College of New Jersey, Princeton, 1883'. That was the thesis by which he won his D.Sc. The newness of much of our engineering practice is suggested by the references in our interview to the introduction of belt-conveyors in mills and to the use of structural steel; likewise the adoption of gas-producers for generating power. In connection therewith Dr. Ricketts had a chance to do honor to John Langton, and he availed himself of it gladly, as in his acknowledgments to Thomas Robins, H. A. Fitch, James S. Douglas, H. Kenyon Burch, Charles S. Shelby, Thomas H. O'Brien, Horton Jones, David Cole, W. D. Thornton, John C. Greenway, C. H. Repath, A. G. McGregor, Charles E. Mills, L. R. Wallace, L. O. Howard, James A. Potter, and Henry A. Tobelmann. It is a gallant company, of whose assistance and fellowship any man might be proud. After all, the choice of men is the larger part of generalship, and in this phase of his more important operations in the field Dr. Ricketts has shown a sagacity of no common order. And if a sagacious man works earnestly, he is likely to succeed. All he needs besides is opportunity and health. The latter Dr. Ricketts had in relatively small measure, for he has often taxed his physical strength unduly, but the wiry frame and the nerve of the hardy stock from which he sprang have stood him in good stead. As for opportunities, they were plentiful in the early days of Arizona and in the later days of big copper enterprises. He was ready for them. He had the qualities to make the most of them. One of the qualities was a mind open to new ideas, willing to accept right suggestions, not unwilling to abandon a pet theory if it were disproved or to discard a favorite method if a better were forthcoming. A willingness to give credit to whom it was due stimulated the co-operation

of his staff. From them we learn that once he has given a job to a man he lets him alone; he shows confidence by not worrying him; he does not interfere except when it is a part of his duty to do so. Under such conditions, as one of them has told us, there remains "nothing to worry about except the possibility of not proving worthy of that kind of confidence". The record of his varied achievements, covering notable accomplishments in geology, mining, milling, smelting, and other branches of engineering, bespeaks a flexible and comprehensive mind, able to make a scientific study of a fresh subject and to apply that study to economic purpose. Another characteristic, essentially scientific, is his refusal to take anything for granted, where doubt exists, in a technical matter. Before he commits himself to a plan of action involving large sums of money, he avails himself of expert advice from the outside. He is not cocksure, but deliberate. That is why he became so successful as a consulting engineer to some of the largest companies operating in the South-West. And with it all he has a sense of humor. William C. Greene, the Colonel of Cananea fame, was persuaded to bore for oil near the copper mines in Sonora, and when he failed to strike oil-sand he asked Dr. Ricketts to advise him where to sink his next well. The answer came promptly: "In Pennsylvania". His friends tell us that—until he was married—he was "not much on clothes". Indeed, there is a story of his having been rebuffed by a Pullman porter, who mistook him for a tramp. Also—until he was married—he was so immersed in his work that he looked upon the wedded state as interfering seriously with more important things. When a chauffeur whom he employed at Cananea disappeared for a few days, he was overheard to say: "I guess he has gotten into some serious trouble. I suspect it's marriage". However, that prejudice of the Doctor was cured in due time, completely. Among other honors that have befallen him we may mention the presidency of the American Institute of Mining Engineers, in 1916, and the award of a gold medal by the Institution of Mining and Metallurgy, in London, for his paper on 'Experiments in reverberatory practice at Cananea, Mexico'. During the last two or three years he has been trying to retire from active work, but his semi-retirement looks a good deal like an average man's busy season. Whenever he does withdraw from the stress of professional work he can do so with a keen

realization of much done, and supremely well done, of having fulfilled to the hilt the definition of an engineer as one who has learned "the art of directing the great sources of power in Nature for the use and convenience of Man", and, more particularly, of enlisting the hearty co-operation of other men in winning metals for the needs of our material civilization.

DENIS M. RIORDAN

AN INTERVIEW

Mr. Riordan, your name is Irish?

It is. My father was Irish, and his forbears as far back as our records go. My mother was English. I am an American, having been born in New York state. Your question reminds me of the time my youngest grandchild came to her mother, crying, when she was about three years old, and amid sobs managed to say: "Aint, ain't m-my grandfawther of Irish deecent?" Her mother responded soothingly that I was. Alicia's rejoinder was: "W-w-well, that's what I said, but Muriel says he is just plain Irish".

In what town were you born?

In Troy, New York, on June 26, 1848.

What was your father's occupation?

My father was a carpenter, of the kind the old country produced when they served seven years as apprentices before they were even allowed to become journeymen. He could do almost everything with tools in wood, except carving.

What was your early education?

I did not get much early education, but what I did get was in common schools, intermittently. I left school for good at the age of ten, and have never seen the inside of a school-house since, except as a visitor. I have worked to help out the family finances and to make my own living, continuously from the age of ten, in Chicago at first.

You speak of Chicago. Your parents evidently moved from New York while you were a child.

They did. My father decided to move to Chicago before any railroad had been completed, and therefore went around the lakes, by boat. Our family landed at Chicago in October, 1852. We lived there until I went into the Army.

You first left home then to enter the Army?

Yes, in 1864. But I started to enlist in 1861; I enlisted five times, but was taken out of the Army each time by my father, until the fifth enlistment. On the fifth I succeeded in getting into the field, in my 16th year.

Did you see much of the Civil War?

Not a great deal. I served with the Army of the Cumberland in the second separate division, mostly on detached scouting service in Missouri and Kentucky, and after being discharged I re-enlisted, which made the sixth enlistment, serving in Tennessee and Georgia, and was finally discharged at Memphis in 1865, after Lee surrendered.

Were you in any battle?

The only engagement of importance in which I participated was the battle of Nashville.

Were you wounded?

I was knocked down by a bullet, which struck the brass plate of my cartridge-box belt, but was not injured.

After the War, what did you do?

I went into various occupations as opportunity offered, the first job being that of a freight brake-man on the Rock Island railroad.

You were getting near the occupation of engineering?

Well, you might look at it that way; I found that there was a decided reluctance to hire a man who had been in the Army. I never knew why, but assumed from the nature of the inquiry, as well as the manner of it, that most employers had the idea that a man who had been a soldier would not work at any regular occupation unless he had to. Therefore, I refrained from mentioning the fact that I had been in the Army until after I got a job and had shown my willingness, at least. I was particularly anxious to have this job of brake-man, although the work was hard, the hours long and irregular, and necessitating exposure to all weathers, because my 'bunkie' in the Army had moved to Davenport, Iowa, which was the end of my run, and I thus gained frequent opportunities for a pleasant visit with him.

How long did you serve as brake-man?

Probably four or five months. My father objected to the occupation, both on account of there being no likelihood of advancement, and on account of the danger.

What did you do then?

Upon leaving the railroad I succeeded in getting employment with Palmer & Leiter, which firm subsequently became Field, Palmer & Leiter, and then Marshall Field & Co. I worked as shipping-clerk with them through these changes, until the fall of '68, when I made up my mind to go West, being then 20 years old. At this my father again demurred, and offered to stake me to a store in Chicago if I would remain and cared to follow merchandising as an occupation. But my experience in the Army and my natural bent for out-of-doors made me determined to strike out for the West. I liked to tackle Nature, rather than human nature; and the building of a railroad, the subduing of a forest, or the opening up of a mine, were even then dreams in my mind. So I went West in January 1869, my first stop being at Bear River in Wyoming, whence I worked on the Union Pacific as a carpenter—being handy with tools, as the result of my father's training—until I reached Echo City in Utah. There six of us decided to leave the railroad and go to Salt Lake City, inasmuch as the approaching completion of the transcontinental railroad was in sight. We went to Salt Lake, and after spending a couple of weeks there, all being carpenters and having our tools with us, we flipped up a half a dollar to decide whether we would go east or west from there. I did the flipping, and West won. So we bought a six-horse team and a wagon and started for White Pine, a booming mining camp in eastern Nevada. We passed around the southern end of the Great Salt Lake and through Tooele across the Steptoe valley, which was then a quagmire, in which we spent three bitter days, thence through Egan canyon, until we made our way into Hamilton, White Pine district, Nevada. That was in 1869.

And there your mining began?

Only in a temporary way. I started to work as a carpenter at $9 per day. Miners were being paid from $5 to $6. Everything was high; to illustrate: flour was worth $36 per hundred, lumber $300 per thousand feet, and all other things in proportion.

It was a typical raw frontier mining-camp in mid-winter. Most of the miners lived in tents or dug-outs, and a reckless good-natured lot they were.

What were the principal mines in the locality?

Up to the time I left there, there was nothing developed that could be called a 'mine'. There were innumerable holes all over Treasure Flat, anywhere from 10 to 50 ft. apart, but each claiming "1500 ft. on this lead, lode, or vein", and it was not at all unusual for a shot put into one hole to throw rocks that fell fairly into the next 'mine'. The ore was principally silver, and some of it ran as high as $20,000 per ton.

It was not long before you went into mining yourself?

I did some prospecting on Treasure hill, but nothing that could be called 'mining'. I worked principally at carpentry. I left White Pine early in May 1869 to go to Virginia City, where I arrived with $1.60. I walked from Hamilton to Elko, something like 180 miles, and also from Reno, with my blankets on my back, to Virginia City, a distance of 21 miles, and on my arrival at Virginia City I took a glass of beer. This cost me 10 cents, and was all I had that day. I then divided the remainder of my fortune into a three-day grub-stake, eating one meal each day while looking for work. I hunted faithfully for a job all the way from Virginia City down Six-Mile canyon to the Devil's Gate and in all the quartz-mills down Seven-Mile canyon, but at that particular time there had been a fire in the Yellow Jacket group and the town was filled with idle men, many of whom were disgusted White-Piners; others had come from the railroad-camps, the transcontinental railroad having been recently completed.

So you had a poor show?

A mighty poor show; but when my last half-dollar was under my belt, I decided, after consultation with Phil Smith, the foreman of the Kentuck mine, to go to the Washoe valley, which I did, afoot, and got a job in Dall's mill at Franktown. I worked in that mill at different jobs, from battery-feeder to amalgamator, but did not learn assaying at that time. In the fall of 1869 I went back to Virginia City, to work underground in the Chollar Potosi, of which I. L. Requa, father of M. L. Requa, was then

superintendent. I worked in that mine until I was again persuaded to change my occupation, going into a store-office, and later, through the friendship of Capt. T. M. Hart, who was time-keeper at the Chollar Potosi, I was brought into a conference with H. M. Yerington, and within two hours I was placed in charge of the business of the Carson lumber-yard, in which duty W. O. Mills, a nephew of D. O. Mills, was my predecessor.

This was at Carson City?

Yes. My duties covered not only the Carson lumber-yard, but grew into the handling of the mills, large and small, that were cutting lumber at Lake Tahoe. When I first went to Carson, the Virginia & Truckee railroad had recently been completed from Carson to Virginia City. The rails and locomotives were hauled by horses from Reno to Carson. I can recall an argument between H. M. Yerington and William Sharon (who was then the agent of the Bank of California at Virginia City), when Yerington was importuning Sharon to support his recommendation that the road buy another engine. They had two engines, but Mr. Yerington insisted that they should have a reserve engine, and should have their trains so arranged as to start one from each end of the road practically simultaneously. Mr. Sharon demurred strongly, but Mr. Yerington's recommendations finally prevailed with Mr. Mills. At the time of this argument the railroad was being run without even a telegraph-line, but before I left the road it was running 40 trains per day and was easily paying 100% per annum.

You are now referring to the Comstock boom, I presume.

Yes, to one of them. From 1870 to 1872 there was a boom on the Comstock. Those who were there at the time will recall that Crown Point stock went from about $2.50 to about $2000 per share; and the shares of other companies, notably the Con. Virginia, Kentuck, and Belcher, made almost equally phenomenal gains.

Did you speculate yourself?

I had no money for speculating. But only a few days ago I met Mr. A. M. Ardery, who was my chum, is now vice-president of the Virginia & Truckee and Carson & Colorado railroads, and is still my friend; he reminded me of the time we decided that

we would put $20 apiece from one month's salary into Crown Point stock. This would have bought us 16 shares at the price then prevailing. We flipped up a $20 piece to decide the matter, the flipping decided against us, and we did not buy.

How long did you remain at Carson?

A couple of years. Then I went back to Virginia City and worked in the Hale & Norcross and other mines as a miner.

What wages did you get?

Four dollars a day.

What did board and lodging cost?

Board cost $8 per week, and lodging anywhere from $10 to $20 per month. Many of us 'batched' and did our own cooking. I was one of three, all old soldiers and members of the same G. A. R. post, that batched in a cabin on the divide between Virginia City and Gold Hill. I had not been long in the mine, however, before Mr. Yerington met me one day and asked if I wasn't tired of such dangerous and heavy work, and if I didn't want to come back to my old position at Carson. This resulted in my doing so, and subsequently I was appointed station-agent at Mill Station in the Washoe valley, where I had a large flume under my direction, in additon to my routine work as agent. From there Mr. Yerington brought me back to his office, and although I had no title I acted as private secretary for him until he asked me one day how I would like to go to Bodie.

When was that?

That was in '78. I don't know whether Mr. Yerington knew I had previously had quartz-mill experience, but I was put in charge of the Syndicate mill at Bodie. There was no job in the mill that I couldn't do with my own hands, but I recognized my deficiencies in that I had no knowledge of assaying or metallurgy. I decided to correct this, and made an arrangement with a Freiberg graduate, who had an assay-office in Bodie, to teach me how to assay for gold, silver, and copper. In pursuance of my ambition to learn, I performed my routine duties until half-past nine or ten in the evening, then went up to Bodie, about a mile and a quarter, and worked until eleven or twelve, as the case might be, then back to the mill, and to bed, and was usually on deck again at half-past five. In addition to my duties as mill-

superintendent, I served as assistant-superintendent of the Tioga and the Bulwer, and looked after all the underground work of the Syndicate, and did all the office-work for the three companies. My superiors were S. B. Ferguson and Warren Rose. My old foreman, John F. Parr, who lives in Berkeley now, and has since been in Alaska, Siberia, South Africa, and other mining regions, and is now mining in Tuolumne county in this State, was one of the most resourceful men I ever knew. We were 120 miles from a railroad. We had odds and ends of six different plants collected from among the idle mills of the then deserted camp of Aurora, in Nevada, and put together in an old mill-building. Mishaps of all kinds were continually occurring, but no excuse would be accepted for allowing the mill to shut down, and we practically had to run it on 'rawhide and wire', and did. Shoes and dies were obtained from Pittsburgh at a cost of about 15 cents per pound. Wood cost $12 per cord. Other supplies in proportion. We had an old 40-ft. two-flue boiler, and an old marine engine, 18 by 40, slide-valve; yet with all these handicaps we managed to keep our milling cost down pretty low—to within $6 per ton, and sometimes as low as $5.

What was your total cost per ton?

We ran mostly on custom ores.

Then you made a profit?

Oh, yes. We received $12 per ton for doing the work. During this time we had one rather unusual run on ore from the Bodie mine, and from this run we produced about a million dollars in six weeks. We seldom could run more than two of the 5-stamp batteries at a time, and frequently only one, because the ore was so rich that it kept the tanks, pans, and settlers full of amalgam. I have frequently known the amalgam to cling to the pan, shoes, and mullers so as to slow down the engine until it would stop on the centre. Any millman who lives near enough to his mill to have it become a part of himself will realize that if a stamp goes wrong, or a belt breaks during the night, it will bring him up out of a good sleep into the middle of the floor standing, almost before he has time to recognize what the sound is. Therefore any old-fashioned millman will recognize the fact that an unusual sound caused by one of the stamps going wrong would cause me to hurry on my clothes and go out to the mill

to find that sometimes the stamp was not striking ore, neither was it striking iron, but that the bottom of the mortar had become filled up to and above the level of the dies until the material overflowed onto the dies themselves, and that the stamp was falling on malleable gold, deadening the sound. Under such circumstances I have removed the screen and filled a Wells Fargo express-box full of gold from one mortar. Pretty good ore!

This ore came from the Bodie Consolidated?

Yes. We got 900 pounds of gold amalgam one day.

How much of this was gold?

About one-third was metallic gold. During the run on this Bodie ore, I now remember sending a message to Mr. Yerington, who was treasurer of the company, announcing the recovery for that day. He made the remark, "Riordan is probably excited. He speaks of 900 pounds of gold amalgam, but, of course, he means ounces. But that's good enough". I did not mean ounces; I meant pounds.

What was the yield of the ore per ton?

It averaged about $1000 per ton; but some of it ran as high as $50,000 per ton.

Was it a pocket?

It proved to be a pocket; and it was opened up quite accidentally, against orders. The Bodie company had sunk a shaft to the depth of 250 ft. on the south end-line of the Standard mine, with a horse-whim. At that depth they started a cross-cut and intersected some 17 veins. The principal vein, which was the Standard main vein, was very low-grade at that point; but one of the night-foremen, finding some pieces of quartz showing free with gold-bearing quartz, the ore running thousands of dollars gold in a vein about 18 inches wide, afterward called the Burgess vein, decided, without orders, to start a drift south on that vein. In 27 or 28 ft. this drift widened out to about 9 ft. and was filled per ton.

What was the later history of the Bodie mine?

That I cannot tell without making fresh inquiries, because I left Bodie in the fall of 1880 and went to Arizona. I only know that before this phenomenal run the stock was selling at about 50

cents per share and that it increased in value on the market to $50 per share, and before the 'pocket' was exhausted it began to pay dividends at the rate of $5 per share per month. I went down to Arizona as the result of a proffer of a position as superintendent of a mine in what is now, I think, Cochise county.

Where was the mine?

It was in the southern end of the Santa Rita mountains. Prior to my leaving Bodie, a number of samples of the ore were sent to me there for assay, together with maps. The samples went within $1 or $2 of the amounts shown on the assay-certificates that accompanied them, and some of them ran over $150 per ton. When I went down there to look the property over, I found that all of the maps and descriptions were accurate. But I also discovered that the ore never came from that mine. That fact had not been stated. So I refused to accept the superintendency of the property.

How old were you then?

About 32.

What did you do next?

The next thing I did was to spend several months with Fred F. Hunt, who is now an analytical chemist in New York City, and who was then covering the South-West in a search for possible copper opportunities for the Orford Nickel-Copper Company, with Thomas A. McElmell, an ex-naval officer, who was a member of the American Institute of Mining Engineers. We three were cabin partners and to a certain extent prospecting partners, especially McElmell and myself, although we had no formal agreement. I decided to take up a property adjoining the Copper Queen at Bisbee, and two business men from Iowa and myself formed a partnership and put some $40,000 into this property in the search for copper ore.

You had saved money from your salary?

I had saved money from my salary and I had made several lucky turns in mining stocks, at both Virginia City and Bodie.

So you were a capitalist?

In a small way. I was always willing and ready to take

chances, and have been flush and broke perhaps twenty times, and expect to be broke again a few times before I pass in my checks. This copper-mining venture at Bisbee not proving profitable, I tackled another prospect in the Silver Bell district, northwest of Tucson, a venture in which one of my previous partners and Senator Norwood, of Georgia, now deceased, were principals. The enterprise languished and finally expired for want of capital.

What has since then happened to the prospects that you tackled both at Bisbee and Silver Bell?

The prospect at Bisbee I do not believe ever developed into a mine, but the prospect in the Silver Bell district was afterward developed by E. B. Gage and Frank Stanton, associated with Frank M. Murphy, into the Imperial Copper Co., which, I understand, has been acquired by the Guggenheims. From Silver Bell I went to Prescott, and there became associated with the then Governor of Arizona, F. A. Tritle, whom I had known previously at Virginia City. Governor Tritle, F. F. Thomas, and myself at one time had the United Verde property under option, but we had to lay down our hands for the want of $14,000. This was before it had been examined by W. A. Clark. While associated with Tritle I made examinations of properties in the South-West and down into northern Sonora, as far as Altar. Subsequently, and perhaps growing out of our intimacy, I was asked by the Governor to take the agency for the Navajo Indians in northeastern Arizona, because rumors had reached the trading-posts of discoveries of valuable minerals—gold and silver, lead and copper—on the reservation. The Governor wanted somebody in whom he reposed confidence to go up there and take charge of the Indians, as agent for the Government; and while in that capacity to ascertain whether the rumors were true.

Before we proceed further, I shall ask whether you had been trying to supplement your practical experience with the reading of technical books?

When I was a 'cub' miner, in Virginia City, a working miner who knew five or six different kinds of rock was regarded as being something of a geologist. For instance, if he knew granite, limestone, quartz, porphyry, slate, and sandstone, he was regarded as being a fellow who was observant and a good judge of rock. I was always desirous to know the reason of things. In working

on the lower levels of the Comstock in bad air I had occasion to notice that the heat of the water coming from the face of the drift was sufficient to cook eggs. I wanted to know what made that water hot. On inquiry among men who had a technical education, I learned that it was caused by the chemical reactions in the rocks themselves when exposed to oxidation.

What books did you have?

Usually none, because of my wandering life. I did manage to get hold of Dana's 'Mineralogy', and occasionally I would have my attention called to some book on geology by such men as Fred Hunt, who knew; and I made it a habit to make a humble exposure of my ignorance, so that I never failed to elicit information from anyone who was near me. Another thing that helped me was that, for a number of years, the members of the U. S. Geological Survey, many of whom I knew personally, including Major Powell, Arthur Davis, Prof. Thompson, and Prof. Hiller, camped in that part of the South-West where I happened to be, and I got the benefit of their criticisms and their observations, in many cases extending back 25 years, while sitting around camp-fires, and the information they imparted would be etched on my memory. In 1882 I became a member of the American Institute of Mining Engineers, and learned more through my acquaintance with such men as Dr. R. W. Raymond, Anton Eilers, George W. Maynard, E. G. Spilsbury, John Stanton, and Charles Macdonald. Some of the younger men with whom I made friends were Arthur S. Dwight, Karl Eilers, Dr. Spencer, and Dr. Hess of the Geological Survey, and such engineers as John B. Keating, Herbert R. Hanley, and others with whom I was in close association both in discussions over practical operations, as well as technical methods.

Then Mr. Riordan, you got your technical equipment from nature and from men, rather than from books?

Exactly so. Or, to put it in another way, I got it from hard knocks and absorption. My books were few.

You have given me the impression that you read a great deal now.

Yes, I do now, but then I had neither the time nor the facili-

ties. Some sixteen years ago I was asked by the General Electric Company to analyze for them 700 or 800 mining reports. I have never quite known how they came to hear of me. But I took up the task, and out of the 700 or 800 badly mixed manuscripts I picked seven mines that I thought were worthy of investigation and recommended that they get some high-class engineer to make the investigations; but, instead of doing this, they gave me authority to choose the engineers and have the investigations made. For a number of years I had a free hand in the making of examinations in various parts of the continent, and naturally in company with these engineers, analyzing the facts they ascertained and giving me the reasons why, I was bound to get some of the knowledge they had acquired by study as well as by observation, but which I could not have got in any other way. Then when I found I lacked information in any particular I would not hesitate to ask where I could get the original authority or the original source of information on this or that point. If I heard an ore spoken of as 'bornite', when I did not know what that mineral was, I made it my business to go and hunt it up. And thereafter that was fixed in my memory. Habitually for 15 years I read reports and articles on mining subjects from two to three hours each day, besides the work I did during office-hours.

Thank you. That answers my question. Now we will go back to your acceptance of the agency on the Navajo reservation.

I probably spent more time on horseback scouring all over the reservation than any agent who preceeded me, and possibly more than any who has been there since.

How long were you there?

I was there about two years and a half, from early in 1882 until the middle of '84.

What did you find?

I did not find anything that could be called a hopeful prospect, but I did find an ingenious system among the Indians of getting samples of rich ore from the San Juan region or elsewhere in Colorado, taking a sample as large as one's head, breaking it into smaller pieces, and giving the pieces to a number of different Indians to show to prospectors. And this in turn developed a carefully devised scheme for awakening the interest of

any 'tenderfoot' or even 'old-timer' whose ambition might be aroused by showing him a sample of this rich ore and describing in a rough way the course of a vein along a hillside and the kind of rocks on both sides of the vein. For giving this information the Indian usually had himself and party well supplied with flour, bacon, coffee, or anything he wanted that could be obtained at the trading-post. Then he would return to his own 'stamping-ground' and a few days later another Indian would come down with another sample and describe a mine in the same locality. Probably a month later the first fellow would return. Every time the Indian messenger showed up he was listened to eagerly and went back loaded with the goods that he wanted. Then the white man would name a time when the Indian would be prepared to take a party up there and show them the locality, and the day would be set and this man would come down from the heart of the reservation to Gallup, or some other point, meet the white man there, and two or three hours afterward another Indian was likely to come tearing in with his horse all covered with foam, with the word that the hearts of the Indians in that vicinity had grown 'bad' and that it was not safe for the white man to go into that region to investigate. They would work that scheme with ingenious variations, until I exploded the bubble. Governor Tritle's idea was, if any valuable mineral was found, to negotiate with the Indians for a right-of-way for a road from the most available point on the railroad or the nearest white man's wagon-road, and thus avoid any conflict, setting aside the district for mining purposes with an amicable arrangement that was fair to the Indians. But, of course, the failure to discover valuable minerals in quantity spoiled everything.

What did you do then?

Edward E. Ayer, of Chicago, who was probably the largest tie and telegraph-pole dealer in the world, and who had a saw-mill at Flagstaff, telegraphed me while I was at Washington with a party of Indians visiting the Secretary of the Interior, to call and see him on my return journey. His first question was: "Do you know anything about a saw-mill?" I said, "Not a damned thing". He said, "You are just the man I want". That resulted in my running the lumber business until Ayer invited me to come to Chicago at $10,000 a year as manager of a part of his business

and a half-a-dozen superintendents under me. This was in 1887. I told him I would rather make a success of that old mill out at Flagstaff and get $1000 a year than to be in Chicago at $10,000. I said I would make a success of the business if it was humanly possible, or leave my bones in the pile of saw-dust. So he sold me the mill, and the only security I could give him was my bones and clothes. Inside of two months I lost $18,000 through the failures of customers; inside of two months more I started in helping to build what was then known as the Arizona Mineral Belt Railroad; I trusted the company to the extent of $40,000, and then the silver panic of '93 came, and the Atlantic & Pacific Railroad went into the hands of the receiver, owing me the $40,000. The lumber business proved a trial alright; but it never failed. It had taken me over 11 years to work out problems that I thought I could solve in three. Even at that time labor controversies were not unknown; and while we had no serious troubles, I decided to put into effect a profit-sharing plan that I had thought over for years, the idea having been suggested by Dr. Edward Everett Hale. It would be too long a story to tell you now, but some day we may have a chance to talk it over. It is sufficient to say that my effort ended in a heart-breaking conspiracy among the beneficiaries; and rather than endure the continuing disappointment, I disposed of my remaining interests at a sacrifice, and left that region, completely cured and freed from illusions on profit-sharing in this country under present social conditions. In leaving Flagstaff I had been encouraged to go to the South, where E. P. Ripley, president of the Santa Fe, and his associates had an uncompleted railroad from Macon to Savannah.

What did you do there?

I went over the portion of the road that had been completed from Macon to Dublin, which was then earning a profit over operating expenses, but not on the bonded issue. It was a good road, if backed up.

What was your work?

It was in the nature of preliminary investigation, for the purpose of advising the owners and making up my mind whether I would take the presidency of the road. However, I had not

gone far before I discovered that while Mr. Ripley, Mr. Soper, and their associates had apparently unqualified confidence in my ability to perform the physical task of completing the road, their chief desire to have me accept the presidency was based upon their belief that I could finance the completion; inasmuch as I had previously succeeded in getting some heavy undertakings of a similar nature financed—that is, heavy for me.

What did you decide to do?

I decided not to accept the presidency, although I told them plainly that if the road were financed I would undertake to complete it and accept the responsibility of its direction. I left. Then I started on a horseback reconnaissance of the Southern States, from Washington to Tampa on the east and as far west as Texas, and in the doing of this I spent nearly two whole years.

Making a mineral exploration?

Not necessarily, although mineral investigations were included in some cases. For instance, I examined tracts of land embracing some 50,000 acres on which there was poplar, pine, and the other merchantable woods of the Piedmont region, but on which it was also claimed there was gold, silver, copper, and coal. Among other tracts I examined was one of 25,000 acres, at the instance of Abram S. Hewett. This property had a wonderful growth of poplar on it, but it also had two horizons of coal that were probably fifty times as valuable as the timber, while Hewett's proposition was to buy the tract based upon the stumpage value of the poplar alone.

Did Hewett buy it?

He did. I may say that I was introduced to him by Dr. R. W. Raymond, who is one of the staunchest and most loyal of friends. Two years of this work brings me to 1898, the year of the Spanish War. I went to Tampa during the preliminary rumblings and was there the night the 'Maine' was blown up, on my way to Cuba to see things for myself; but I was stopped. My family was in Europe at this time, and I had been keeping in mind the possibility of a home in the South, but decided to give it up and return to the West. Upon my return to Arizona, I went to Tucson, and while there was invited by Epes Randolph

and Eugene S. Ives of Tucson to become an investor in the King of Arizona mine, north-east of Yuma. At that time the four principal owners and stockholders were Randolph, Ives, Blaisdell of Yuma, and S. Morgan Smith, a manufacturer from Pennsylvania. The mine had been discovered by a man named Eichelberger and taken over under option from him by Randolph and Ives. Smith was an ex-minister from the South, and was the principal person who put real money into the venture, besides myself. I was elected president of the company, and had for manager a nephew of Marshall, the discoverer of gold in California, Thomas Marshall Irwin, a bright young fellow. He died while in our employ, in Arizona.

What happened to the King of Arizona?

We were not a happy business family. I was not long in discovering that each of the three Arizona directors entertained a very poor opinion of Smith, and of each other, except as they could combine forces to do up Smith without coming within the grasp of the statute law. And each expressed an opinion of the others, as I do when I do not want to be offensive and describe a man as a steward. For a good mouth-filling definition of a steward I would refer you to Kent's answer in the second scene of the second act of 'King Lear', to the question of the steward: "What dost thou know me for?" I wrote to each one of my associates repeating what he had said about the others and asking him if my recollection of his characterization was correct. In each case my correspondent replied that my memory was not at fault, whereupon I called a meeting of the board at which all were assembled, and placed the correspondence before them.

Were any of them armed?

It is fair to assume that at least two of those present were heeled. But nothing happened other than that they became less acrimonious, and after some interchanges requested me to see if I could not do something to bring about the sale of the property. Then I told them they would either have to nominate other representatives on the board or secure another president and general manager.

What happened?

They decided to give me an option on the property at a sum which was a good round figure for such a property at that time, but its subsequent development and production has apparently justified the price they then asked. However, I did not succeed in disposing of the property for them, and while I was in New York on other matters, in 1900, I was in the old Engineers Club on Fifth Avenue when I was asked by a representative of the General Electric Company to meet some of the directors with a view to examining into the feasibility of their searching for copper-mining opportunities. After a preliminary conference I was invited to examine a mine for which they had negotiated and upon which they had made a preliminary payment. This mine was in New Hampshire, not far from Berlin. I suggested that they send a high-class engineer to make the examination, and this resulted in A. R. Ledoux undertaking the task. When Dr. Ledoux was chosen I assumed that this would result in my not going, as I was not under definite engagement with these people; but they asked me to accompany Dr. Ledoux, which I did. While we were at the mine together, our investigations were independent of each other. After his return Dr. Ledoux made an elaborate report on the property. I made none; at least none in writing, and openly declared that I would not attempt to make a mining report either as confirmation or as correction of the report of a man of Dr. Ledoux's standing. I did not regard myself as competent. My habitual term, in speaking of myself, was that I was a sort of a saw-mill metallurgist, and my experience has taught me that I could not truthfully claim to be anything more. When a man has reached the age of 48 or 50, if he is honest with himself, and intelligent, he usually has made a pretty accurate mental analysis of himself. Others may flatter him and regard him as a very much higher-grade man than he does himself. Still others may have a depreciated opinion of him; but he ought to know what he is himself. And while I am bound to know that a great many men of the highest standing in the profession regard me as a competent man, nobody knows as well as I do myself how keenly I recognize my deficiencies. My training was of the most haphazard character, as you must have recognized already, and entirely the result of some previous experience growing out of my being plunged into the vicissitudes of

the frontier under conditions which compelled me to undertake the running of a lumber-yard this year, building a piece of railroad the next, running a quartz-mill the following year, and perhaps appraising timberland the next.

What happened to the mine in New Hampshire?

My principals took my advice and forfeited the payment they had made, but I never made any report on the property. After Dr. Ledoux's report had been received, one of the directors came to me and asked me whether I intended to make a report myself, and I said, "No, I do not regard myself as competent to submit a report upon a mine which is intended either to confirm or to correct the report of an engineer of Dr. Ledoux's professional standing". Then the director asked me, "Will you tell me this? Will you tell me what you think of that mine? And will you tell me what you would advise us to do?" I said, "I will do that. I think the mine is not worth a damn. I advise you to forfeit the payment you have already made and make the best settlement you can with the entrepreneurs". The promoters of the mine were Dr. Edward Peters and a man named Elliott.

Did that lead to your being retained by the General Electric Company?

It did. There were turned over to me 700 or 800 reports of mines of all kinds and descriptions. I was asked to go through them carefully, and to select some one or more that I regarded as being promising. This resulted in my choosing six or seven—among which were the Shannon, in the Clifton district; another in the Cananea district; the entire Shasta county, California. group; the Granby at Phoenix, B. C.; the Britannia on Howe Sound; the Wall property, in Bingham canyon, now the Utah Copper; and two or three others—the Tezuitlan and the Inguaran. in Mexico.

Was it a question whether the General Electric people should purchase shares in companies operating these mines, or whether it should purchase the mines and operate them themselves?

The idea was that the General Company would operate the mines themselves.

How many mines did the General Electric Company proceed to operate and how did you select those they did operate?

When I gave the directors who had the matter in charge, notably, C. A. Coffin, Robert Treat Paine, and Gordon Abbott, the list of mines and districts in which I thought the possibilities were sufficiently good to warrant an investigation, they asked me if I would undertake to secure engineers to make the examinations. I told them I would, so we selected W. Lawrence Austin, Thos. Marshall Irwin, T. S. Mathis, who had previously made some examinations under the supervision of Ellsworth Daggett and Hinsdill Parsons; Mathew J. Walsh, E. Gybbon Spilsbury, Martin Schwerin, John H. Mackenzie, and others. Usually, especially in the case of mines situated in our South-West, I knew somebody in the district who was familiar with local conditions and upon whom I could call for a preliminary opinion.

Would you give the names of those who helped you in this way?

They were J. C. Smith, Capt. Berry of Globe; M. P. Freeman of Tucson; Charles Akers of Phoenix; T. G. Norris, Hugo Richards, and others at Prescott; and one or two each in Bisbee and Tombstone whose names will not come to me on the instant; and several old Comstockers whom I knew in Nevada.

What mines did your company acquire?

Upon the technical recommendations of Mr. Austin—and my endorsement, of course—our people decided to take up a number of mines and prospects in and about Hanover, New Mexico—the Ivanhoe group—and something like a hundred claims stretching along the railroad in what are known as the Upper and Lower Basins, in the vicinity of Fierro and Hanover, were put together under the name of the Hermosa Copper Company. My principal aim in making these recommendations was to establish a basis for the acquisition of the Santa Rita property, which was then owned by J. Parker Whitney, of Boston. In the early days of the Hermosa I had an exhaustive examination of the Santa Rita property made by John M. Sully. This examination cost us considerably over $10,000, and included over 4000 samples from various parts of the property, and I unqualifiedly recommended that our people take the property over, but they failed to do this. The property is now owned by the Chino Cop-

per Company, which has something like 80,000,000 tons of developed ore according to the latest estimates; and the man who made the examination for us is the manager, Mr. Sully.

What happened to the Hermosa?

We started on the recommendations of Frank H. Probert, who confirmed all of Mr. Austin's previous recommendations, and decided to take the property over; but it did not respond to our work as was hoped. It is now being operated in a rather small way by lessees, and recently some of our people have been recommending that they rehabilitate the property and resume operations.

What other properties did you acquire?

The only other property we acquired was the Bully Hill in Shasta county, California.

This has done well, has it not?

It did well, very well, until the Government began to make trouble about the smelter-fume. The Bully Hill proved to be a good property, but my original recommendation was not the acquisition of the Bully Hill alone, but the combining of it with the Mammoth, and my still earlier recommendation was to take up the whole Shasta group of copper mines.

Why was your recommendation ignored?

That I am unable to say. But there was always a strong feeling among some of our important directors against the company going into mining at all, and a whispered negative would outweigh the strongest positive recommendation.

When did you acquire the Bully Hill?

In 1905.

Were your headquarters in California?

I kept my headquarters in New York, but spent from two-thirds to three-fourths of my time in the field.

Aside from your mining activities for the General Electric Company did you engage in any on your own account?

I did. As a matter of fact, I was always engaged more or

less in mining activities in what might be regarded as a small way. But sometimes these ran into considerable amounts of money for one of my means. I was always 'grub-staking' prospectors, all over the mining regions with which I was familiar. I directed some drift-gravel mining in Calaveras county, with Matthew J. Walsh as superintendent, after the investigation staff of the General Electric Co. was cut down to the minimum; and I also became identified with hydraulic mining in Trinity county, California, at the La Grange mine. I was treasurer and managing director of this property for a number of years, becoming its president after the death of Robert Mather, who went into the venture when he was president of the Rock Island. Pierre Bouery, a French engineer, was the manager of the property, and a mighty good manager he was. This venture proved profitable to all interested; subsequently the property was sold to English capitalists for whom Baron de Ropp was the managing director in this country. We took out over a million and a half dollars during our operating period of some seven years.

Does your connection with the General Electric Co. continue?

It does. Some five years ago I resigned my position as president of the various subsidiary companies that had been formed and recommended that John B. Keating, who was manager at Bully Hill, be elected in my stead. Mr. Keating is a trained metallurgist, a fine mining engineer, and an exceptionally good business man. It has always been my habit, and one out of which I have derived a great deal of pleasure, to boost the younger men. I never consciously wanted to be the head of anything. I would rather be the trusted right-hand man to some man whose character and ability commanded my respect, than be the boss. And usually I preferred to have a younger man in the position of the executive head, rather than occupy that position myself. But from the time I began work with a pick and shovel and wheelbarrow, even where there were no more than two of us together, and even if the other man was older than myself, the boss always seemed to look to me for a lead. But when Mr. Keating took charge of the Bully Hill and other properties, as president, he and his assistant, Herbert R. Hanley, started to solve the Bully Hill fume problem by electrolysis instead of smelting. That work

has been going on for over three years now, and is just about completed.

You are going to erect an electrolytic zinc refinery?

Our people are not, that is, not immediately, but the Mammoth company has passed favorably upon our process, after an elaborate examination by the heads of their metallurgical department.

Can you tell me what process you are going to adopt?

In most essentials, I judge, although I have not seen the Anaconda process in operation, it is similar to the method devised by Laist and Frick, although in some important respects prior to that. Mr. Hanley, who was the assistant-manager at Bully Hill, was the man who elaborated the process and who found out the way to do things which were sometimes baffling, and, under Mr. Keating's supervision when he happened to be there, they worked out the methods to the point where the process seemed sufficiently developed to invite the Mammoth people to examine it with a view to the erection of a plant.

By the way, Mr. Riordan, I met you in London when you came over to aid the refugees at the beginning of the War.

I remember. I was deputed by the Secretary of the Treasury to accompany the officials of the Treasury department to Europe, the entire party on board the 'Tennessee', on which we sailed, being composed of representatives of the State, War, Navy, and Treasury departments.

You were bringing money to aid American refugees in Europe?

Yes. We took over $1,500,000 of Government money, and something like $3,000,000 of money that was hastily got together by the leading banks of New York, Boston, and Philadelphia, for a similar purpose.

I remember your telling me how nearly the 'Tennessee' became the victim of a floating mine.

Yes. It was a close call, although we did not know it at the time. The Dutch government ordered one of the boats which were patroling the coast to accompany us far enough out to sea to do the honors and to note the direction in which we sailed.

The last time I went back to England from the Hook of Holland, it was reported that the boat that escorted us, after turning around to leave us, was sunk by a mine and went to the bottom. It is fair to assume that we had a narrow escape.

You have now settled in California?

I believe I have. I opened an office here last year, but I have been such an Arab on the face of the earth that for years I have not dared to count on a permanent residence. I have had to travel, until within the last year, probably 25,000 miles per annum for 20 years; and have wandered from the mines of Cariboo to Bolivia, and habitually crossed the Continent from three to five times a year. I probably traveled 30,000 miles in Arizona alone, on foot, on horseback, and by buckboard—most of it before the railroads entered the Territory.

THE SCHOOL OF EXPERIENCE

*In this issue we publish another of those biographical records from which so much of human interest can be learned. Our subject, Mr. Denis Mathew Riordan, is a veteran whose kindliness of heart and wide sympathy with all that concerns the profession have kept him young amid the vicissitudes of a checkered career. That career did not start in the conventional way; he did not graduate from a school of mines or a university; he did not have an indulgent uncle to give him a job as soon as he wanted one; on the contrary, he had a struggle to reach even the lowest rung of the ladder that leads to promotion and success. A carpenter and the son of a carpenter, he began life with but little prospect of achieving his present place as an honored member of a highly technical profession. Perhaps he was fortunate in the time of his debut, for the Civil War was followed by a remarkable era of mineral exploration and industrial development. He followed Greeley's advice and came West, to grow up with the country that offered many chances to the intelligent and energetic; but first he did his duty as a good citizen by serving as a

*Editorial in the 'Mining and Scientific Press' of October 6, 1917.

soldier. In these days when 'slackers' are not far to seek, it should be more inspiring than amusing for our young men to read of the boy that tried five times to enlist before he succeeded in getting into uniform. Those who know Mr. Riordan need not be told that the soldier-boy of 50 years ago is a keen patriot today and as eager to serve the national cause now as he was then. We met Mr. Riordan in Europe when he went thither on the 'Tennessee' to distribute the funds for American refugees, and we recall that he avowed himself 'neutral', but he used the word in an ironical way that left no doubt abut his feelings on the subject—feelings strengthened by later events. He served a varied apprenticeship: soldier, brake-man, shipping clerk, carpenter, millman, miner, all of these occupations he tried before, at the age of 22, he obtained a position of responsibility as superintendent of a lumber-yard. But the call of the mine was insistent; he returned to Virginia City; and when 30 years old he won his first real promotion, becoming superintendent of a stamp-mill at Bodie. He tells the interviewer how he taught himself in his spare time, overcoming not easily, but slowly and laboriously, the lack of a special training. We were not at Bodie in 1878, but from another we learn that Mr. Riordan was "a live wire" in those exciting days; he was ambitious and speculative; he was fond of hunting, proving himself a good scout but a poor shot; our informant remarks that "he had to shoot oftener and tramp farther than most of us, but he always got birds". Apparently he was persistent in small as well as in big things. He was keenly interested in politics and local affairs, as he is now in national and world affairs; his mental horizon has been enlarged, but his mind is as full of movement as heretofore: never provincial, he asserts the best right of civilized man: to make all knowledge his patrimony. When working underground on day's pay he began to acquire scraps of mineralogy and geology. As a young man he had the good sense and the good fortune to make friends among the leaders of the profession, and to learn from them by daily association more than books could tell. The reading of reports and technical writings was supplemented by an intelligent inquisitiveness. He was never afraid to acknowledge ignorance and always quick to ask questions. Here is a hint to our young men. Nothing is more foolish than the false assumption of

knowledge, the intellectual 'bluffing' that checks the acquirement of accurate information. To realize ignorance and to be eager to correct it are the marks of the real student. Later, in his first experience with the General Electric people, Mr. Riordan was true to form; he refused to undertake work for which he considered himself unqualified; he was glad to avail himself of the assistance of specialists. His saying is true that a mature man, if intelligent, and honest, knows his capabilities and his limitations, and is wise if he recognizes them. He knew his own and that made him a safe adviser. Our readers will note with keen interest the names of the mines he selected as likely to become profitable enterprises. Any man might be proud of such a record. It was the result of native sense, keen observation, and wide information. Again there is a lesson for our young friends: the proper study of mankind is man; to know men is better than to devour books; the understanding of one's fellows is capital of an indestructible kind. The interview also suggests that men differ greatly in their capacity to be helped by their surroundings; some sink to the bottom, others swim to the top. "Men live their future now. They determine by today's behavior and aspiration the strength or weakness that will tomorrow honor or shame them." Such is the moral of this story; but no maxims can give to a man the genius of friendship. This our friend possesses, and it is the very crown of life. He has the social gifts of quick understanding and willing co-operation; more particularly the happy knack of making congenial persons known to each other, for work as well as for pleasure. His friends know him to be a charming letter-writer and a winning teller of stories either by mail or across the table. The equanimity shown by him in times of trouble is largely the product of an essential sanity and of a philosophic temperament disciplined by a keen sense of humor—a salt that is the savor for making palatable even the unpleasant happenings of checkered days. And one thing more this mining engineer possesses, and shares with his fellows freely: an innate kindliness that has found fruition in acts of service to the less fortunate whose trails he has crossed. Many that read this will jump to affirm what we have just said, for in his trail across the waste places of the earth where mines are found there grow for him many flowers of grateful remembrance.

ARTHUR THACHER

AN INTERVIEW

Mr. Thacher, you are a New Englander by birth?

Yes, I was born at Newtonville, Massachusetts, in 1857.

Was your father interested in mining or in engineering?

No, he was a merchant.

What was your early education?

In private schools in New York City, and then the School of Mines, in Columbia University, from which I graduated in 1877.

What induced you to go into mining engineering?

It was through friends, such as James E. Mills, the geologist, who made the report on Mine La Motte, W. H. Radford, of San Francisco, whom you know, and Bayard T. Putnam, who worked with Pumpelly.

Were these in your class at Columbia?

Putnam was two years ahead of me, but Radford was in my class. When I started I was not sure what I wanted; so I entered for Civil Engineering, but Dr. Chandler suggested that I add Mining, because the course was better. Afterward, finding the mining course more attractive, and becoming more interested in it, I went through with it, although I took the two degrees.

This explains how you took to mining engineering, but what made you think of engineering in the first instance?

When at school I was quick in mental arithmetic, and my teachers thought that I was going to make a mathematician, so they recommended engineering, but when I got into Columbia under Van Amringe, I soon found that I was no mathematician.

As you know, I have known a great many Columbia men, especially in my early days in Colorado, and I was puzzled for a while to account for their general high level of success in their profession until I made up my mind that it was due to the severe course in mathematics under Van Amringe; in other words, the song "Do ye ken Van Am?" expresses a tradition of which Columbia may well be proud. What do you think?

There is no doubt that Van Amringe did leave a great impress on all the students, but he was ably seconded by others of the faculty, and while their scientific work may not have been anything remarkable they did give to the students a broad view of the engineer and of his work.

Having graduated, how did you get your first job?

A friend of my father's, Charles E. Tilton of Ladd & Tilton, bankers, at Portland, Oregon, was in New York in the fall of 1877 and strongly urged that my place was out West. Therefore I accompanied him to San Francisco in December of that year.

What sort of a town was San Francisco then?

San Francisco was just getting over the boom days of the Comstock, and everybody was interested in mining; even the waitresses were looking for tips on mining stocks.

Did you have any trouble in getting to work?

No, thanks to Mr. Tilton's introductions, there was not much trouble in securing a job, although I had to wait a few weeks. I then accepted work for Mr. Brooks, who was operating the Progreso mine, at Triunfo, in Baja California. They were using the old hyposulphite leaching process.

You went there as assayer and surveyor?

I went there to assist in the assaying, but before long I had the surveying and, later still, charge of the refinery.

How long did you stay there?

I remained there about a year. The place was isolated, and I became restless to go elsewhere, so I went to Arizona, arriving there during the boom days of Tombstone.

To what place did you go in Arizona?

I went to Arivaca and Oro Blanco, about 60 miles south of Tucson. There was a good deal of mining and prospecting going on, and for the next few years I was engaged in assaying, prospecting, and contracting work.

Those were the days of Indian troubles; did you ever come in contact with them unpleasantly?

Personally I never had any such experience, but the Indians were out frequently on their raids and a number of my acquaintances were killed.

Do you recall any members of the profession you met at that time?

W. A. Hooker visited Arizona at that time; John A. Church was operating at Tombstone; Charles W. Goodale and William P. Blake were thereabouts.

So you had a pretty good local practice?

Yes.

How did they pay in those days?

Professional work was not well paid, and what we made on contracting work we usually blew into prospecting, so we just about kept even.

What did you do next?

In 1883 I went back to New York and opened an office there. For the next few years I was doing consulting work. In 1885 I went to the Viola mine in Idaho, where a class-mate, Ralph Nichols, was in charge and spent a year or more with him as his assistant. The deposit was one of those large masses of lead carbonate; the furnaces were erected during my stay, and we had good practice in the mining and smelting of lead ores.

You still retained your headquarters in New York?

I went back to New York in December 1886. William B. Potter, who had just lost his father, Bishop Horatio Potter, was looking for somebody to help him in his professional work in St. Louis, and in January 1887 I joined him on the recommendation of W. A. Hooker, who was a class-mate of Professor Potter at the Columbia School of Mines, class of '71.

Potter was Professor of Mining in Washington University, was he not?

Mining and Metallurgy. Soon after reaching St. Louis he was called away and I had to take his classes and lectures for him. This was entirely unexpected and an altogether new experience for me.

You found it helped you?

It was as good as a post-graduate course, for I soon found the students were further advanced in some of their studies than I was, and I had to sit up nights to keep ahead of them. Sometimes I worked until one or two in the morning so as to be prepared for my students.

What was your title?

I was Adjunct Professor of Metallurgy, and continued to do the work until they abolished the Mining course at the University in 1891.

Meanwhile, you had been assisting Potter in his professional work?

Yes, in the State of Missouri, and also farther west. At that time Prof. Potter was in charge of Iron Mountain and some other operations near St. Louis.

When your work as professor ceased, did you remain with Potter?

Yes, I remained with him. Shortly afterward I accepted a position with the Central Lead Company in south-eastern Missouri. I had charge of the operations, and later was made president and general manager, until the property was sold to the Guggenheims in the spring of 1905. It now belongs to the Federal Lead Company.

So, during this period you probably had your first contact with large-scale mining operations?

Yes, this was a splendid education for me, as we had concentrating mills and furnaces, and it also gave me an insight into labor conditions. Fortunately we had an excellent board of directors, and they supported my efforts.

Among your labor experiences, did you have a strike?

Yes, we had a serious strike during the winter of 1903-'04. It involved not only the miners' union, but about ten of the other labor-unions in the district, including the building trades. Gompers, Moyer, and Mitchell all took a hand in the strike.

Well, you have had similar experiences since, I presume, and you probably have a definite notion as to the best way to settle the industrial conflict? Do you believe in collective bargaining?

No, I do not believe in collective bargaining, as it is generally understood. I believe in full co-operation with your own workmen and permitting them to have a good deal to say about the conditions under which they work, but without interfering in the management of the property.

Please go ahead and state your ideas as to the best way for decreasing the friction between employer and employee.

The friction will never be decreased until the management endeavors sincerely to help the working-men, not from a selfish motive, but in the realization that the men are human beings. The management must learn that success can only come from close co-operation in the work. Anything that helps the workmen helps the whole operation. In the past we have been under the impression that we must have autocracy or slave-driving, and that the function of the management was to look for defects. If we reverse this and really try to help the men, if we look for what good there is in them, and for what they are doing well, we can get much better results. I do not believe that the world is moved primarily by the dollar sign and the selfish motive: I believe that the paramount motive is the desire for achievement, and under proper stimulus this can be developed for the good of all concerned.

You think that this applies to the uneducated as well as to the educated?

I believe this applies even more to the uneducated than to the educated. They are quicker in discerning selfish motives and they will respond quicker to kindness and the square deal. You can more easily deceive your board of directors and the public than you can your men, and if you really do not believe in the men it is hopeless to expect that you can by any words make them think

that you do, or conceal any selfish reason you have for trying to urge them on.

This can be illustrated even with animals, for a dog recognizes his friend and detects his enemy. The idea of achievement as the controlling motive can also be illustrated by the child who will spend time in trying to build his blocks a little higher, simply for the desire of creating something new.

Then you think that this dominant desire is inconsistent with collective bargaining as conducted by unions?

Yes, our present system of unionization is not founded on true representation. Collective bargaining has a tendency more to pull down to the lower level of efficiency than to encourage the men to greater effort.

But the employers are unionized; capital generally acts in unison?

True, and I do not object to the employees being unionized, but only to the present system, which does not give true representative control.

How would you improve it?

The men should do away with their present system of voting, and adopt the secret ballot, and thereby obtain a true system of representation instead of a dictatorship.

What made you leave the Central Lead Company?

The sale of the property to the Guggenheims in 1905. For the next year and a half I was doing consulting work for the Guggenheims and others, and then went with the New Jersey Zinc Company. Back in 1890 I did some work for this company at Joplin, and not being able to remain with them at that time, I suggested Pope Yeatman in my place, and he took up the work. After Yeatman's return from South Africa, when the New Jersey Zinc Company was taking up Western work, they retained Yeatman as their Western engineer, and on his giving up the appointment in 1906, he suggested that they retain me.

What sort of work did you do for the New Jersey Zinc Company?

The principal work was the development and operation of e Wisconsin mines, although we also developed mines in Colo-

rado and Nevada, New Mexico and Arizona, and did some work in Old Mexico, before the Revolution.

Did you have any special experience in the Wisconsin zinc region?

Yes, I had an opportunity there to develop some of my ideas in regard to the handling of labor. We had a little group of men that followed me from the Central Lead Company and were thoroughly imbued with the same ideas on the handling of labor, especially B. A. Hoskins, whom I met first in 1879 in Arizona, and with whom I have been associated ever since. Mr. Hoskins was born in Wisconsin in 1849 and got his early mining there and afterward went to the copper mines of Lake Superior, and then to Utah, where he introduced the first hand-jig in Bingham canyon. Later he was at Pioche. He was without a technical education, but he had a wonderful insight into human nature and had the best ideas of the controlling force of the working-men; to his teaching I am indebted for any success I have had with working-men. As an illustration of what we were able to accomplish, I give you the following:

	Number of mines	Tons per day	Tons per man	Earnings per shift	Cost per ton	Tons per day per mine
1908	1	130	2.7	$1.84	$0.68	130
1909	1	143	2.9	1.94	0.67	143
1910	3	611	4.0	2.24	0.56	204
1911	3	1045	4.5	2.42	0.54	348
1912	3	1039	5.2	2.48	0.47	346
1913	3	1242	5.4	2.49	0.46	413
1914	4	1874	5.7	2.51	0.44	468
1915	6	3091	6.9	2.83	0.41	515
1916	6	3919	7.7	3.22	0.41	653
1917	6	3633	7.5	3.47	0.46	605
1918	5	2803	8.0	3.74	0.47	561

We were fortunate in being isolated from labor-union conflicts. Even during the War we were not as much disturbed as other parts of the country, although we lost most of our good men by volunteering and the draft. I think this tabulation of results illustrates the fact that if we pay attention to the handling of the men and really try to help them, they will in turn help us. The results obtained, although they are good, are still not near what they might be. Even the figure of 8 tons per man, I believe, under favorable conditions, could be raised to as high as 20 tons per man, without any increase in the use of machinery. During the

period that this table covers there was no noteworthy increase in the use of machinery, the only exception possibly being the drill, which was improved, but it would have made only a fraction of a day's difference in the results, because we had very few drillers —only five in the average mine. In the case of the hand-shovelers, we increased the amount shoveled from 12 or 15 tons to an average of 55 tons per shift, and with high records of over 100 tons per man per shift.

This was all done without any bonus system, or without the use of the contract system?

No, the shovelers were on piece-work, but I do not attribute our success to the piece-work, for in several instances we increased the speed on day's pay even more than we did on the piece-work. The difficulty with piece-work is that whatever scale you first introduce, you start at such a low efficiency that you are having an ever-broadening gap between piece-work and day-work. It is perfectly apparent that you cannot reduce the rate for piece-work without discouraging the men; or what amounts to the same thing; if you increase the day's pay. The difficulty is that you have a widening gap, which can never be successfully bridged and be fair to the men.

What did you do next?

At the present time I am in general consulting work, although still retained as a consultant by the New Jersey Zinc Company.

Mr. Thacher, I am aware that you declined the nomination to the Presidency of the American Institute of Mining & Metallurgical Engineers, but you take a keen interest in its affairs, I know, and I would like to ask you what you consider should be its chief functions?

It seemed best for the Institute that I should decline the nomination at this time, but I believe the Institute is one of the greatest powers that we have for good. It has not commenced to take the place to which it is entitled. We must, however, give the matter careful attention and note the fact that we have not altogether been following the right lines. In our eagerness for representation, which is entirely proper, we now have a condition that gives us a paper representation, which is totally inadequate. While it is very nice to elect a director from an outlying Section, we must

realize that as the Institute is an incorporated body, a director cannot act by proxy, or by letter ballot. If he is unable to attend the meetings, we have only the name, not the representation. If we recognize this fact, I think we can, in a large measure, overcome these troubles by letting the Local Sections elect men who may be residing even temporarily in the East and who would be able to attend the meetings and represent their interests. We also have another method of representation, for we find in the constitution of the Institute that the chairman of each Section, or his representative, is invited to all the meetings of the directors, and he receives the minutes of the meetings. It is true, he cannot have a vote, but my own experience on the board was that any representative from the West had more influence with the board of directors than if he had even been a director, for they were inclined to consult local sentiment and be influenced even when they were not enthusiastic about the matter in question. What we really need is that the Sections shall become more consolidated, so that they will take a more unified action in matters that come before the directors.

Do you mean that the chairman of the various Sections should correspond with the chairman of the other Sections, so as to elicit local opinion on subjects coming before the board of directors?

Yes. First, let the questions be taken up by the Local Section; then let it get other Sections that are influenced by the same considerations or viewpoint; then if they send on something concrete to the directors, they are sure of getting a good hearing.

Then you believe in decentralization?

Yes, I believe in a true republican organization, in which the individual and the small units shall become more active and attend to their local needs and wishes and requirements, while still retaining the national organization for more limited functions. Just how these can best be worked out is a little difficult to say, but with a frank discussion of all the questions and a knowledge of the facts, I have every confidence that the engineers can work out an acceptable solution of the problem.

Do you believe that the Institute is more effective today with its larger membership than it was when it was a smaller and a more compact organization?

There is no reason why it should not be even more effective with a larger organization, providing that these are proper members, because we can see that in the future we are going to be many times as big as we are now, for the engineering profession is going to grow and take a more prominent part in all public affairs. It is only a question of organization, so that we can develop the real resources of the engineer. We now have something like 10,000 members, but in the future we are going to have double or treble this number, and it is up to us to lay the foundation so that the Institute can operate successfully with the larger membership.

I would like to ask you whether you think, or do not think, that the publishing activities of the Institute are excessive?

This cannot be answered in a few words. Necessarily the mining engineer covers a broad variety of subjects. To satisfy the requirements of the mining engineer we have to publish papers on widely divergent subjects. The only solution seems to me to be that we must classify our publications and have a series of different volumes, letting each member be entitled to one or two of these volumes and pay an additional price, or the cost of printing and paper, for any of the other volumes he may desire. It is true this would largely curtail the efforts of those who wish to complete a set, but we are having such a mass of literature on all subjects that most of us have felt that we could no longer accumulate all of it, and, personally, I have commenced to break my sets and give away volumes in which I am not interested. This happens with our State Geological Surveys, which cover broad fields. Most of us are only interested in one or two of the subjects and we find it utterly impossible to house all the publications that come to us. Thus, in our Institute most of our metal miners are not interested in oil and do not care to receive the papers on oil. We have also many members who take only a mild interest in any of the publications, and they certainly do not wish to be flooded with printed matter.

Do you think that the fundamental purpose of the Institute is to promote the solidarity of the profession and to bring the members together at social gatherings, and of late years to express the considered thought of the profession as a

whole, to do these three things, rather than to act as a publisher, a work that is being done fairly well by other agencies already established?

There is a good deal to be said for this view of the case, but there are many papers that it seems necessary for some society to publish. It does not, however, mean that every member of the Society could possibly read all the papers. There are plenty of points of contact on general propositions, of engineering, labor, and so on, where we could all unite, although I fully agree with you that the main thing is to promote personal contact among engineers. It is quite clear you cannot get this adequately at national meetings, so we must develop the sectional meetings.

I forgot to ask you a question on the subject of education. You were a teacher, and you have been a practising engineer: you are, therefore, in a position to have a definite opinion as to the kind of education a mining engineer ought to have?

On the general question of education we may divide the subject into three classes; scientific, artisan, and engineering. In the case of the scientist, he is called upon to deal with natural laws; his training and work do not make him excel in the work of engineering. The artisan is simply learning the manipulation of processes. The mining engineer, I believe, requires an entirely different training. The mining engineer is the pioneer, the builder of civilization; his training must include the study of literature, economics, finance, and all the branches of knowledge that make for civilization. Naturally, he must have the sciences, but more particularly the applied sciences. If we look at the engineer in this light, we shall see that he has a place in the future that is broad, and that he will have a tremendous influence in the world.

Then you believe in a liberal education instead of a mere preparation for a bread and butter dependency?

Certainly; in my own experience, what I have missed more than anything is a classical education.

How would that have helped you as a mining engineer?

The mining engineer, if he is an operating man, must take his position as a leader in the community. He must control mankind, not only in relation to his board of directors and the public, but

with the working-men; unless his ideas are broad and he understands humanity and is able to express himself, he cannot be effective.

Then you maintain that a classical education broadens a man's mind?

It certainly does; but more than this, it gives him the power to express his thoughts, either written or spoken. Without this power, no matter what his ideas are, he can make no success.

How about Abraham Lincoln and John Bright?

While Lincoln did not have the opportunities for school education, he was a big enough genius to overcome this defect, and wherever he got his education, we can see the results were simply classical.

Then by 'classical' education you do not mean the learning of Greek or Latin?

Well, I should include Greek and Latin, for most of us have not the genius of a Lincoln to omit this help and succeed.

What do you consider the future holds for mining engineering as a profession?

I think it holds grand possibilities. I think we are just at the start of an era in which the engineer is coming into his own. We must remember that engineers, as we understand them today, were unknown fifty years ago, and that as regards great enterprise in our industry it is the engineer that can be, and from his training is, the best fitted to achieve results.

You have no fear of the exhaustion of our mineral resources or cessation of mining on a large scale?

None whatever; I think we are only in the dawn of our mineral development. Years ago I used to be worried for fear our resources might become exhausted, but it is simply a question today of our being compelled to exploit lower-grade material. The material is in abundance, if we can handle poorer stuff. Of course, this will naturally increase the price, but the price will not prevent the use, for when we carry it to its ultimate consumption, the price of the crude metal usually does not play a part of more than 5% in the cost to the ultimate consumer. For example, an

automobile does not carry over a ton of pig-iron, equivalent to two or three tons of ore. If the cost of the finished automobile be a thousand dollars, the difference in the cost of the original pig-iron is immaterial.

What do you mean by that?

Whether the pig-iron is $20 or $40 per ton, it makes very little difference to the cost of the automobile as sold to the user of it.

Meanwhile you realize the continuing and growing demand for metals?

Certainly I do, because if we go back fifty years and look at statistics for the world, we find insignificant figures for all our metals; and if this past fifty years has given us our tremendous growth, what will the next fifty years do? We have nowhere near reached the saturation point of consumption in the civilized countries, and we have more than a billion people that are coming along for consumption as they become civilized.

MR. THACHER OF ST. LOUIS

*St. Louis became prominent as an American mining centre when a number of its citizens grew wealthy by reason of the bullion that was yielded by the Granite Mountain mine at Philipsburg, Montana. That was 35 years ago. The Granite Mountain distributed thirteen millions of dollars among the people of St. Louis and stimulated the market for silver mines in that city. We are not forgetful of the fact that St. Louis was the distributing centre and in a measure a financial centre for the lead mines of south-western Missouri, at first for Joplin and later for the Miami and Picher districts, which transgress the boundary of Missouri and extend into both Kansas and Oklahoma; nor do we overlook the Flat River district and the celebrated Mine La Motte, which was productive for nearly two centuries. Nevertheless the flush days of the Granite Mountain marked a period when St. Louis was most prominent in Western mining, for they co-

*Editorial in the 'Mining and Scientific Press' of February 25. 1922

incided with the successful development of Butte and Leadville. Many mining engineers found scope for their abilities in these operations. We have interviewed two of them: first Mr. Philip N. Moore; now Mr. Thacher. Both are New Englanders by descent and come from the old stock that has leavened the lump of American nationality. Both graduated from the Columbia School of Mines. Both therefore had a preparation, hereditary and educative, fitting them for a useful career. As usual, Mr. Thacher's first opportunity for work—his first 'job'—came through the kindness of a friend. Young graduates are inclined to think that their degree is a ticket to employment; they do not realize that as technical fledglings they are not worth the first salary they are paid, and therefore that they owe their entry into practical life to the goodwill of a friend. He gives them the chance to make a start and to make good. Every engineer will recall the friend to whom he owed his start, and ought to cherish his memory with gratitude. Indeed, one of the privileges of the older men is to give a helping hand to the young fellows. Mr. Thacher owed his start to Charles Tilton, of a firm still honored at Portland, Oregon. He came to San Francisco and went to the Progreso mine, which continues in operation and is about to be acquired by the Boleo company, one of the most successful of French enterprises on this continent. His door of entry was assaying and surveying, occupations that have provided bread and butter for many young men at the beginning of a mining career. Mr. Thacher had the good sense not to stay too long at one mine but to spend his years of least responsibility in widening his experience. So he went to Arizona. There he came to grips with the realities, by engaging in contracting and prospecting, both of which gave him an idea of the value of money and of the need for applying business principles to mining. It was a good start. Later he supplemented this practical training by reverting to a scientific education, for, as he himself says, the five years that he spent at Washington University in association with Professor Potter were to him a post-graduate course, of which he made the best use. Indeed, if life were not so short, it would be well if all of us could return to college after our first ten or fifteen years in the field, for by that time we have learned how little we know and we have dis-

covered the things that we need most to know. When Mr. Thacher left Washington University he lost no time in getting into harness as a manager of a mining enterprise. He was fortunate in being connected with one that proved successful—so successful as to be bought at a handsome price by the Guggenheims twelve years later. The task that brought him a modest fortune and an honorable reputation was his reorganization and management of the old Central Lead Company's property in the Flat River district of south-eastern Missouri. Under discouraging circumstances he developed this enterprise to a successful issue; he carried it through the period of depression in the early 'nineties when lead fell to a price of less than 2½ cents per pound; by aid of tact and persistence he more than held his own against overweening competitors, bringing the property to a condition so prosperous that the Guggenheims purchased it for a million and a half dollars without any commissions. The best mine in the group was under water at the time the sale was made, and the buyers acquired it on the strength of Mr. Thacher's own statement concerning its ore-reserves. His work, among other things, involved the application of geology, for he surmised that the lean orebody exploited by his predecessors was not the chief ore-horizon of the district, so he sank the main shaft deeper and opened up one of the richest and largest of the orebodies found in the 'disseminated lead' belt. It was his confidence in his own judgment that caused him to buy large blocks of shares from the old stockholders. During his management of the Central Lead Company he had his first contact with the labor problem, a subject in which he has retained an eager interest ever since. Although a man of generous spirit, and what one may call economic sympathy, he has no faith in the ordinary methods of collective bargaining, and does not hesitate to give his reasons therefor. On the other hand, he is a keen advocate of friendly co-operation between employer and employee, and believes sincerely that the compelling motive to good work is not the wages alone, but the desire for achievement; in short, he credits the workman with what most of us arrogate to ourselves as the professional spirit. His advocacy of the secret ballot at the meetings of labor-unions is one that will commend itself to those familiar with the manner in which the unions are dominated by the rougher and less re-

sponsible element. Many strikes are started by an open vote in the small hours of the morning, by which time most of the quiet men have been intimidated either into acquiescence or departure, and at an hour when most of the married men have gone home. What unionism needs is the participation of all the workers in the system of collective bargaining, not domination by a coterie of radicals. We understand the laboring-man's dislike of the 'scab'—the laborer who takes the place of a striker—and believe that it is best for our economic system that all laborers should join their unions, especially the married, conservative, and more intelligent type of workman. Mr. Thacher gives his views on the subject in an outspoken manner; he speaks with the confidence of experience and the sympathetic insight of a humane man. The figures he quotes, to show the output per day in the Wisconsin zinc region, are most significant as showing what can be done when men are treated properly. Our readers are aware that Mr. Thacher's name was mentioned recently in connection with the presidency of the Institute, and it was by his own wish that the matter went no further at this time. He has been, and continues to be, a loyal and effective worker for the Institute. What he says concerning the system of representation is much to the point. The directorate has been a figure-head affair because, out of a board of 24, only six or eight—those resident in New York or near it—attend the meetings. The effort to establish representation by means of directors from the outlying Sections has proved a disappointment because men living at a distance from New York have found it impracticable to attend the directors' meetings. The result, inevitably, has been to throw the control of Institute affairs into the hands of a small group in New York—in short, the control has been distinctly oligarchic, instead of republican, as it is bound to be when headquarters are at one end of a continental country 3000 miles wide. The Institute, like many another expression of modern—especially American—enterprise, is suffering chiefly from bigness, with which goes shapelessness, mere bulkiness, like a fat man with a weak heart. Mr. Thacher discusses this phase of the subject in his replies to the interviewer; he also answers frankly the questions submitted to him on the subject of the Institute magazine. Next we come to Mr. Thacher's ideas on education. He has been a teacher himself, and he has seen

enough of the results of conventional education to be able to speak confidently. It is interesting to note his advocacy of a cultural training for engineers; he recognizes the power that comes to men from their ability to express themselves, and he has seen many examples of effectiveness that were frustrated by the inability to speak and write efficiently. The interview closes on a cheerful note, for Mr. Thacher asseverates his complete confidence in the revival of mining and in the continued expansion of the industry. At the time of our interview the outlook was not as good as it is now, but these periods of depression are a necessary part of human life in its broadest sense, and it is the sign of a healthy mind to be sanely optimistic. Only the old, the sick, and the distempered remain pessimistic for long. A cheery forward-looking temper is essential to sane living; without it we could accomplish nothing. Mr. Thacher has that temper or temperament; he belongs to the cheery, helpful, and kindly type of men, willing to assist in all good works and ready to give a cordial hand to his fellows; but no cynic can say that his kindliness marks weakness; on the contrary, he is a man of essential courage —moral and physical. We recall the stories told us about the way he acted during the strike in south-eastern Missouri when his mill-crew refused to do a few minutes work outdoors to move a railroad-car, and how he discharged them promptly, causing the strike to spread and the pump-men to 'come out', so as to drown the mine. He is not only honest in the ordinary sense, of course, but he has the much rarer quality of intellectual honesty; he thinks honestly. The interview suggests that. He is not a man that plays much; his pastime is to think and talk. He has no hobbies but his friends. He is eminently sociable, using that word in its economic sense. During the years immediately before the War and even during the War period, in the face of advancing wages and the decreasing efficiency of labor, he has been able to show, from year to year, lower costs, higher wages, and larger output per man per day. This he accomplished largely with green foreign labor, in a non-union district, by virtue of his own friendly methods. That is an achievement of which any engineer may be proud.

HORACE V. WINCHELL

AN INTERVIEW

Mr. Winchell, you were born in Montana?

No, sir; in Michigan, in 1865.

Were your parents of New England origin?

My father was born in New York State and my mother in Vermont.

What was your early education?

I attended the public schools of Minneapolis and the University of Minnesota and finished at the University of Michigan, graduating in the class of 1889. I went there to study with my uncle, Alexander Winchell, who was then Professor of Geology in the University of Michigan.

Your family has been conspicuous in geology, has it not?

My uncle, Alexander Winchell, was one of the early State Geologists of Michigan and Professor of Geology for many years at the State university. My father, Newton H. Winchell, a younger brother of Alexander, was, for a quarter of a century, State Geologist of Minnesota, and Professor of Geology in the University of that State for many years. These two brothers with others established and my father edited and published during its entire existence of 18 years 'The American Geologist', which was the first monthly geological journal published on this continent.

So you were brought up in an atmosphere kindly to mining? You intended when a boy to become a mining engineer or geologist?

I did; my interest has always been in the practical side of geology and in connection with the application of that science to the art of mining. I have never been interested in the other branches of geology, such as paleontology or stratigraphy.

After graduation at the University of Michigan, what did you do?

Prior to graduation even, I was engaged in geological work with the field-parties of the Minnesota survey, assisting my uncle, who was engaged in that work for two or three years, and my father, in the study of the iron-ore regions of northern Minnesota. Immediately after graduation I began work as an assistant on the Minnesota survey and made a special study of the Mesabi iron range.

What was the result of this work?

The first result of this geological investigation was a joint report by my father, N. H. Winchell, and myself upon the iron ores of Minnesota, a volume of 430 pages, published in 1891, a year before the first production of ore from the Mesabi range. The geological map that accompanies this report was prepared and printed in 1890 and upon this map was shown for the first time the approximate location and extent of the Mesabi range. I was so convinced at that time of the importance of the Mesabi, although it had not yet been explored, that in that report we made the prediction that its production would exceed that of the Gogebic range in Michigan, which at that time was one of the wonders of the world and produced much the largest amount of high-grade iron ore mined in any one district.

What has been the production of the Mesabi range since then?

The Mesabi range, since its first shipment of ore in 1892, has produced approximately five hundred million tons representing nearly three hundred million tons of pig-iron. It now produces more than 50% of all the iron ore mined in the United States; and if it were not for this supply, it is perhaps not too much to say that it would be a physical impossibility for the United States to play its part in the present war.

Having accomplished this geological reconnaissance, what did you do next?

The general report upon the iron ores of Minnesota was followed in 1892 by a report of my own upon the Mesabi range. This was the first report upon this region describing its extent, its geology, the character of its ores, and attempting to estimate the cost of production and its relative importance in the iron industry.

This report was re-published a number of times* and was used by all of the prospectors on the iron range for several years. Its conclusions were confirmed by Monograph LII published some fifteen years later by the U. S. Geological Survey, by Charles R. Van Hise and Charles K. Leith.

Were you given proper credit for your earlier work?

Not at all; my report was barely mentioned. By the way, that reminds me that, in 1890, I wrote an article in the 'American Journal of Science' suggesting the origin of the Lake Superior iron ores by chemical oceanic precipitation. This theory, which was ridiculed at the time, has later been adopted holus-bolus by the Lake Superior geologists of the U. S. Geological Survey as their fundamental concept, likewise without reference to the first presentation of the idea.

So you became thoroughly familiar with the geology of the iron deposits?

The fact that I was optimistic regarding the Mesabi range led to my employment early in 1893 by the Minnesota Iron Co., which was at that time the largest producer of iron ore in the world, under the direction of Don H. Bacon, subsequently in charge of the operations of the Tennessee Coal & Iron Co. and now residing at New York, where I saw him a few days ago. My association with Mr. Bacon was one of the pleasant experiences of my career. He was always stimulating, sympathetic, and appreciative, and was easily brought to a belief in the importance of the Mesabi range at a time when other iron men were unbelieving. If Mr. Bacon's plans had been adopted, the control and management of the best deposits of that region would be vastly different today.

What objection was there to the development of these iron resources?

It will be remembered that there was a period of financial depression in 1893; at that time there was not a great demand for iron ore; those who were interested in the iron mines were also interested in steel plants, and they believed that if the Mesabi possessed such vast deposits as were indicated by my report, iron

*Trans. A. I. M. E., 1893. Vol. XXI. p. 644.

ore would have very little value. For that reason they were dilatory in buying the lands which I recommended and which Mr. Bacon urged them to purchase. The result was that other interests, notably John D. Rockefeller, acting on the advice of W. J. Olcott, and appreciating their value, acquired various properties almost as rapidly as they were developed and soon controlled many of the largest deposits. At that time I used to write an occasional unsigned editorial for the 'Iron Trade Review' of Cleveland, the recognized organ of the iron-ore industry. In one of these editorials, I remember analyzing the consumption of iron ore and pointed out the fact, which in a short time became evident, that all the ore of the Mesabi range would soon be needed to keep up with a greatly expanding industry, and that, instead of a calamity, it was a blessing to the country, because it became available in the nick of time.

Can you quote from that editorial?

In the 'Iron Trade Review' for February 16, 1893, under the caption 'Is There a Shortage of Bessemer Ore?' I called attention to the dwindling of supplies, and reached the conclusion expressed above, stating that "there is most decidedly a shortage, amounting almost to a famine, in the visible supply of Bessemer ore. The day of more general utilization of the basic process of steelmaking may be nearer at hand than is generally supposed".

Observing that the information contained in articles regarding the reserves of iron ore in the United States, published in England and abroad, were, in most cases years behind-hand, I prepared for the North of England Institute of Mining and Mechanical Engineers a paper upon the Lake Superior iron-ore region. This won for me the medal awarded for the best contribution to the transactions of that technical society in that year, and in that paper I made what was then considered the wild guess that the Mesabi might produce five hundred million tons of iron ore.

When was this?

In 1896.

How long were you engaged in your work on the iron region of Minnesota?

The financial depression of 1893 brought about a cessation

of exploratory work by the Minnesota Iron Co., in 1894. I then engaged in general practice and, in connection with it, established a chemical laboratory at Minneapolis in partnership with F. F. Sharpless. This laboratory starved through a precarious existence for less than two years. My professional connections from that time became more and more diverted to the Western mining districts.

To which districts in the West did you go first?

My first examination of mining property in the West was made for James J. Hill in 1894; he sent me to the State of Washington to examine iron ore and coal deposits. I also recall examining gold mines at Murray, Idaho, and in the Black Hills of South Dakota, in 1894 and 1895. Later, in 1898, I went to Butte at the instance of David W. Brunton, to study the Anaconda mine, in connection with apex litigation in which Senator W. A. Clark was plantiff and the Anaconda Copper Co was defendant.

How did you meet Brunton?

I met Brunton at a meeting of the American Institute of Mining Engineers in Minnesota in 1897. I prepared a little handbook for that meeting, descriptive of the various iron mines, and acted as a kind of guide to the members on their visit to the iron ranges, pointing out the interesting features and describing the geology in little talks on the spot. My next meeting with Brunton was on a train in Colorado, early in the following year, on which occasion he broached the idea of the Butte engagement. I promptly declined, saying that I had assured my wife that there was one place in the world where she never would have to live, namely, Butte, but Brunton's persuasive arguments induced me rashly to make a proposition, which I had no idea would be accepted. The result was a telegram from Marcus Daly, saying "When can you be here?" I agreed to spend one year at Butte, but actually spent eight. During this time I was engaged in the organization of a geological department for the Amalgamated Copper Co. This was organized after I began my residence at Butte, about the year 1900.

I remember meeting you at Butte in 1898 and being impressed by the spacious room all lined with books in which you had your office and remarking the fact that you were able to do your writing amid thoroughly congenial surroundings.

That was in 1901, I think. My early efforts as an author impressed upon me the necessity for books of reference. When writing the volume on 'The Iron Ores of Minnesota', I prepared a bibliography and found it necessary to send East to borrow many books of reference. Libraries in the West at that time were and perhaps even now are incomplete; hence with the library of my uncle, Alexander Winchell, as a nucleus, I began spending all my spare cash in the purchase of books. This resulted in the collection of an excellent library upon the subjects in which I was interested.

So you began to participate in apex litigation?

The particular lawsuit which brought me to Butte lasted more than one year and was settled finally in favor of the Anaconda company by a court decision that was based entirely upon geological structure. It was in this case that the existence of the so-called Blue veins of Butte was first announced, These veins have proved to be some of the richest and most important in the Butte district.

When was your attention first drawn to the theory of secondary enrichment of copper ores?

In studying the ore deposits of Butte, I had the invaluable assistance and co-operation of Clarence King, N. S. Shaler, R. W. Raymond, Louis Janin, J. P. Iddings, W. H. Wiley, and others. King's interest in the subject, his breadth of mind, his wide experience, were most helpful. He was one of the most delightful and interesting men with whom I have ever been associated and his memory has always been a source of inspiration. In connection with the solution of our problems it was important to be able, if possible, to distinguish clearly between the old Anaconda vein and the later Blue vein; both of them contain rich copper ore and yet one is clearly later than the other. It was necessary to show in what respects their mineralogy differed.

The occurence of the chalcocite suggested to me, freshly from the study of the iron-ore deposits of the Lake Superior region, where descending waters have done all the work, that formation of at least a portion of this chalcocite might be due to the action of descending waters. This idea had not, so far as I know, ever been suggested or discussed previously. In order to test the possibility of such chalcocite deposition, I secured permission to establish a chemical laboratory in which to conduct the necessary research. My chemist was C. F. Tolman, Jr. Chemically, our difficulty lay in finding the reducing agent that would reduce cupric sulphate to cuprous sulphide. The only chalcocite and bornite recognized as secondary, and mentioned in chemical literature up to that time, was that found upon the bronze coins discovered in the hot springs at Bourbonne les Bains, in southern France. The French chemists attributed the formation of these minerals to the reducing action of organic matter. My first experiments, therefore, were with the use of all sorts of organic compounds. The invariable result, however, was not the formation of any sulphide of copper, but the native metal. Its formation in such a manner is illustrated in the fire-zone of the mines at Butte and in other districts where the mine-waters have penetrated charred timbers and deposited scales and particles of native copper to their very core.

May I suggest also the deposits characteristic of the Permian sandstone in western Siberia and in the Ural region, where native copper is deposited on fossil remains, particularly those of plants?

Yes; I think this is characteristic of the Permian in many parts of the world, such also as Texas and the Mansfeld district in Germany. I remember finding in the bottom of a shaft at Butte an old tarred manila rope that when unwound disclosed a mass of native copper, several inches thick, encrusting the rope. Finding that organic matter did not produce sulphide minerals, we experimented with hydrogen, and with hydrogen and ammonium sulphides, and the sulphides of the alkalies, inasmuch as the rock minerals contain soda and potash; but here the result was not chalcocite (Cu_2S) but covellite (CuS). In connection with the study of the processes of oxidation we discovered that

cupriferous iron sulphide produced sulphurous acid, whereupon we thought that this might be the long-sought reducing agent. Using therefore mine-waters of known composition and a jig-concentrate from the Parrot mill, and a solution saturated with SO_2 in jars sealed from the air with paraffine, we were gratified at finding in a few months that all the copper previously in solution had been deposited as crystallized chalcocite, coating the fragments of primary ore. This was the first time that chalcocite had been produced synthetically and it was a demonstration of the possibility of its formation from descending sulphide solutions; in other words, this was the starting point for the theory of secondary sulphide enrichment, subsequently elaborated by Emmons, Weed, and Van Hise. It is interesting to note that Van Hise's conclusion was based entirely upon deduction from chemical principles, whereas my conclusion was based upon experimental research.

When did your research culminate in this discovery?

In 1899 or 1900.

Then it was a pure coincidence that Van Hise's deductions appeared on the same date as the announcement of your results?

Oh, no; my announcement was not made until two or three years later in a communication to the Geological Society of America. My lips were still sealed and I was unable to do any writing for publication during the progress of the litigation at Butte. It was thought that if I promulgated a theory which could by any possible means have a bearing upon the litigation, and that if my theory seemed to favor the side I represented, I should be accused of attempting to frame a case in advance; if, on the contrary, it could by any interpretation be made to favor the other side, it would be used against us. The date of the experiment and of the discovery, as given just now, is stated in the proceedings of the Geological Society of America, Vol. 14, page 269.

To what did you turn next?

During the next eight years, that is, until 1906, I was in charge of the geological department of the Amalgamated Copper

Co., and the results obtained by regular systematic recording of observations underground were so satisfactory that many other mining companies followed suit and established departments of geology. This was one of the earliest experiments along this line, and such pioneer work seems to have been well justified. A large part of my work was in connection with the Heinze litigation, but there were also many outside investigations and examinations of mines all over the West and in Mexico, for the Amalgamated. When the Heinze troubles were settled in 1906, I left Butte and became Chief Geologist for the Great Northern Railway Co., a position that I occupied for about two years, with headquarters at St. Paul. During this time, I explored iron-ore properties in Minnesota and large coal deposits in Wyoming, Montana, and British Columbia, and purchased lands containing hundreds of millions of tons of both coal and iron.

When did you go to Alaska?

I have made ten trips to Alaska; my first extended trip was in 1903. During the summer of that year, I spent several months in the examination of copper mines both along the coast and in the interior, particularly in the Copper River region. My examination was made for H. H. Rogers, John Hays Hammond, and their associates. It was part of my duty to look into the question of railroad construction in that region and to report upon the general prospects for the development of valuable mines. No law at that time had been passed by Congress for the location of coal in Alaska. This was first permitted under the law of February 1904. On the occasion of this visit, I had an amusing experience with Stephen Birch. Mr. Birch was in charge of what is now known as the Kennecott mine; he had been instructed by telegram, which was taken overland more than a hundred miles by an Indian, under no circumstances to let me see this property. He carried out his instructions faithfully, although it was the Fourth of July, and we were regaled with Scotch and cigars, his military force to the number of nine men being each provided with a loaded rifle and a bottle of whiskey wherewith they successfully repelled invasion. Since leaving the employ of the Great Northern Railway, in 1908, I have been engaged in general practice with an office at Minneapolis and

during that time have visited most of the mining regions in North America, besides others in South America, Europe, and Asia.

When did you get into the controversy over the Cunningham claims in Alaska?

My first intimation of the existence of coal in Alaska came from H. T. Burls, an engineer associated with Sir Boverton Redwood. I met Burls on my Alaska trip in 1903. He was then on his way to examine an oilfield near Cold Bay, west of Kodiak island, and I accompanied him. Burls told me that he had twice before examined and sampled high-grade coal outcropping in thick seams back of Controller bay. He told me that a large tract of land had been staked by an English company in this district and that the quality of the coal was superior to that of any to be found elsewhere on the Pacific Coast. As already said, there was no law providing for the location of coal in Alaska and although the English company at a considerable expense long maintained their operations and possession of their properties, and did considerable development work, yet the lands were taken from them by the United States government. Some years later, in 1909, I learned from M. K. Rodgers, lately deceased, that a number of claims had been located under the law of 1908 by Clarence Cunningham and 32 associates. Rodgers brought samples of this coal to St. Paul and showed them to Mr. Hill and myself. He was then in charge of the construction of a railroad from Katalla to the Kennecott mine for the Guggenheim interests. This railroad was never completed. There was not a good harbor and the winter storms destroyed the breakwater and harbor improvements, which had been constructed at the cost of more than $1,000,000. Becoming somewhat interested and believing that there was a great need for first-class coking-coal on the Pacific Coast, I looked up Mr. Cunningham and investigated the status of his claims. I found that he and his friends had located 33 claims in one group and that their claims had been developed in accordance with the terms of the act of Congress, that they had been approved for patent and that the requisite payment, amounting to $52,800, had been made to the General Land Office, and that these various claims were held by

the original locators. Acting under the advice of competent lawyers, I proceeded to acquire some of these claims, before patent, but after the issuance of a receipt from the Commissioner of the General Land Office. I visited these claims myself in 1910, in company with competent geologists and coal-mining engineers, notably, Frank C. Greene, of Cleveland, and my brother Prof. A. N. Winchell of the University of Wisconsin. On the way to Alaska we were shipwrecked in the middle of the night and our vessel, the 'Ohio', went to the bottom with all our equipment. This made it necessary for us to return to Seattle in order to procure new supplies, instruments, and other outfit, so that our examination of the properties was delayed. This was not the first time that Mr. Cunningham, in attempting to acquire and develop in Alaska an important industrial product for the Pacific Coast, had been shipwrecked. The property was difficult of access and the hardships he underwent and the undoubted good faith he displayed in that entire unfortunate affair deserved a better fate than was accorded to him by the conservation-mad administration at Washington. The action of the Government in confiscating these claims, and in retaining the money paid for them, is to my mind one of the black spots on our national escutcheon and comparable only to similar happenings which have come under my own observation in Russia and the Argentine. In spite of the fact that the special Commissioner appointed to look into the charges against these Cunningham locators found nothing whatever against their integrity or honesty, and in spite of the fact that two subsequent Commissioners recommended the issuance of patents, still, under the slanders and foul insinuations of Gifford Pinchot and one Glavis, the Secretary of the Interior arbitrarily cancelled these claims, blackening thé reputation of the good citizens who had located them in pursuance of the invitation contained in an Act of Congress, after subjecting them to great expense in sending attorneys to all parts of the world—London, Rome, and Paris—to take the testimony of every living locator, and even kept the money that had been paid the United States government for them. This was followed by an ingenious act of Congress withholding from patent forever the coal-lands of Alaska and setting aside as a reserve for naval purposes these particular Cunningham claims,

thus making it impossible for the claimants ever to get into Court and have their rights vindicated.

So you devoted a good many years to this bitter controversy and to your attempt to obtain justice?

Yes, it was somewhat difficult for a time for me to feel the deep sense of pride and warm patriotism which should be in the heart of every American. It was a bitter pill to me.

When did you go to the Argentine?

In 1912 I made the acquaintance in England of a prominent Argentino, Dr. Julio Pueyrredon, the brother of the present Minister for Foreign Affairs in that country, who handled the notorious Dr. Luxburg of 'spurlos versenkt' fame his walking-papers. By Señor Julio Pueyrredon I was invited to go to the Argentine and acquire petroleum lands in Patagonia, near the port of Comodoro Rivadavia. This oilfield is the most important in the Argentine; it was discovered by the Bureau of Geology and Hydrography while sinking an artesian well on a desert coast for water. The oil is not of high grade but it is of considerable value in the absence of coal mines. The land was located under the Argentine mining law and the title was supposed to be good. I went down there early in 1913; I found an interesting district and had a pleasant excursion. Before I left the property, however, the President of the Argentine Republic, imitating the action of the United States in a similar case already referred to, issued an order cancelling all the locations, creating a Government reserve 40 miles square, and instructing the Administrator of Public Works to proceed to develop the land by drilling wells, to make harbor improvements, and to build an oil-refinery. When I returned to Buenos Ayres and expressed my willingness to complete the purchase of these properties, I found that title could not be obtained. I was told that the Argentine law specifically forbade the Government to engage in any mining operations, which appeared to be true, as I discovered by translating into English the entire Codigo Mineria, which manuscript I still possess; and although I was further advised that the President had no authority to cancel the locations made validly under the law, nevertheless these locations were cancelled and I am informed that the Government controls the entire oilfield today. Such arbitrary

acts are not only manifestly unjust, but so weaken the confidence of those having money to invest in the development of mines that in many cases important mineral districts remain idle and unproductive. What a boon it would now be to our country if Alaska were producing several thousand tons of coal per day! It is there in abundance, safely 'conservated' for future generations instead of being developed and used at a most critical period.

You have been in Russia recently, Mr. Winchell, and you have formed some idea of the present condition of the country, particularly with regard to participation of Americans in the exploitation of mineral deposits in Siberia?

I spent six months in Russia in 1917. During a portion of this time I was accompanied by Charles Janin and Ira B. Joralemon. We arrived in Petrograd the Sunday following the revolution, and found the people of that metropolis in a strangely exalted and ecstatic frame of mind. Although sub-zero weather prevailed the people were parading the streets in groups discussing the form of government which they intended to establish. The poor misguided uninformed people had an idea that the millenium had arrived and that they were thenceforth, without delay and without undergoing any period of adjustment or reconstruction, to live in idleness and luxury. Having no idea of the problems of government nor of the organization needed in carrying on the business of the nation, they looked upon themselves as the most wonderful creators of new schemes of existence that the world had ever seen. It was perfectly apparent that disappointments and trouble were in store and that idleness such as they evidently contemplated could lead to nothing but misery.

The resources of Russia and Siberia are so varied and so vast that it is impossible within the limits of this interview to enter into any discussion of them. In many lines there should be opportunity for development; forestry, agriculture, mining, and manufacturing may be successfully developed and there will some day certainly be an opportunity for the business men and the engineers of the United States to play an active part in the work. I fear, however, that the Russian people have not yet seen the bottom of the grade. They are rapidly sliding downhill into a condition of anarchy and degradation which has al-

ready and will still cause the loss of many lives and the destruction of a great deal of property. It is too soon to expect the establishment of a stable government and the restoration of conditions under which the investment of foreign capital and resumption of commerce and industry will be possible. Since my return I have constantly endeavored to impress upon the people of the United States a feeling of their moral responsibility toward Russia. It seems incredible that this great nation could so long stand aside and refrain from assisting the better elements of Russia in their program of rehabilitation. Without our assistance it must be years before Russia is again habitable in the modern way; with it, and the co-operation of the Allies in this present war, stable conditions may be restored rapidly. At the present time there is no safety for life or property, and titles are insecure. It is my belief that there will be a certain amount of disintegration, but that there will emerge eventually a Russian nation whose system of political economy will incorporate many advanced socialistic ideas, some of which perhaps may be an improvement upon anything the world has heretofore known.

You have taken a leading part in arousing public interest in the defects of our mining laws, particularly those based upon the so-called law of the apex. Will you please state definitely your attitude in the matter?

An overwhelming majority of the mining men of the United States are opposed to our present Federal Mining Law. It is only here and there that some theoretical and ultra-conservative student of the subject expresses himself as in favor of the retention of the law of the apex. This unfortunate provision of our laws is a constant source of expensive litigation and is a handicap to the mining industry.

There are several other features of the present laws that do not adequately protect the prospector in searching for and developing our mineral resources. There is no provision under our present system for opening to exploration by the public at large those vast tracts of land which have passed out of the Government ownership into the hands of private individuals. Most countries have retained some jurisdiction over their mineral resources and make it possible for the prospector to enter upon any lands, whether owned by the government or by individuals,

under provisions which safeguard the rights of the individual owner, and to sink shafts, drive tunnels, or explore by drilling for underground orebodies. The time is approaching when all the public domain will have passed into the hands of private owners, and in many cases these lands will thus be not only withdrawn from the field of the prospector, but foreclosed against his operations by the unwillingness of the private owner to permit mining and prospecting work. The inevitable result will be a decline in the mining industry. It is well known to all of us that mines do not live forever. As you, Mr. Rickard, have well said, "even Methuselah died"; and the production of ores in such an active country as the United States can only be maintained over long periods by the discovery of new mines. For this reason I have advocated the incorporation of some provision in our statutes providing for the development of mines upon all lands sold by the Government to private individuals. I believe it may even be necessary, in view of the court decisions upon this matter, for us some day to adopt an amendment to the National Constitution declaring the mining industry paramount and making it possible for mines to be developed wherever they may be found, regardless of the wishes of the owner of the surface, but at the same time making a suitable provision for recompensing him for surface ground actually occupied and for damage to crops and improvements.

Do you think that there is any prospect of amending the mining laws in the near future?

There is not only a prospect that the laws will be amended, but they are actually being amended and not always under the advice of competent and experienced mining men nor in ways best calculated to promote the general interest of the industry and the country at large. There is a great deal of inconsistency in the present laws as applied to the various classes of mineral products, and there is frequently a conflict between the clashing interest of the agriculturist, the stock-grower, the lumber-man, and the miner. The subject is one that should be submitted to careful analysis and study by representatives of the interests involved, and the laws should be given a thorough revision so as to make them as simple as possible and at the same time productive of the best results. I see no immediate prospect for

such a revision as this. It has been recommended time and again by the Secretaries of the Interior and by Presidents in messages in Congress without eliciting any general response. What is everybody's business is nobody's business, and this subject which affects in many ways every individual in the country is understood by few and neglected by all.

You have taken prominent part in the work of the American Institute of Mining Engineers. I would like to ask you what you consider to be the principal functions of the Institute as an organization of Mining Engineers?

The existence of such an organization rests primarily upon and can only be justified by its usefulness to its members, and the industry which they represent. I should say the underlying concept is that of service; service, first, to its members by furnishing them with some means of becoming acquainted with each other, by giving them in published form the results of the latest discoveries and developments in their chosen field of work, and by providing a forum for the discussion of questions upon which different opinions are entertained; service to the industry at large and to the communities in which such industries are operated; service to the country by increasing its productivity and efficiency and in supplying the minerals needed in commerce, manufacturing, and in all the manifold requirements of an industrial nation.

These are days of organization; of co-operation and of joint effort. No man is sufficient unto himself alone; the best results in all lines are achieved by a combination of minds and of efforts. It is my belief that the attention of the American Institute of Mining Engineers should be directed to every branch of political economy and national life with which the production of minerals and their utilization is even remotely connected. I believe that the engineer in the past has been too secluded, too much engrossed with his own particular and individual problems, and that his services and information have not always been as fully utilized for the general public good as their real importance justifies. Nothing has made this idea more emphatic than the events of the past few years. It should be the effort of every engineer in the period of reconstruction to take an intelligent and active part in the problems which are now arising for solu-

tion, recognizing, as he must, the fact that the achievements of engineers and the production of our mines have made it possible for us to play our part in the world conflict now coming to a close. We must realize further the great field of expansion which lies just ahead. It is a source of pride to every member of the Institute to know that its policy is now so shaped as to enable it to take its part in the work.

The mining industry must and will be expanded. We are on the eve of important developments and are entirely confident in the ability and the intention of the American engineer to take a prominent rôle, both at home and abroad.

A MINING GEOLOGIST

*In these days when we review, with sadness and affection, the career of Dr. Raymond and go back to the beginning of scientific mineral exploration in this country, it is brought home to us how recent has been the use of geology as an economic instrument of industry. In the days of the founders of geology, of such men as Lyell and Murchison, for example, the study of geology was an amateur's hobby, which feared the taint of commercialism and deemed itself gentlemanly so long as it abstained from helping people to make money. We have traveled far from that aristocratic idea; we cherish the democratic ideal of using geology, as any other science, for furthering the welfare of man; we have discarded the old-fashioned notion that any science loses caste by becoming utilitarian. In this country Clarence King and his comrades led the way by their work in the Fortieth Parallel exploration and by founding the U. S. Geological Survey in 1879. At that time the geologist was retained by the Federal Government for the purpose of guiding the development of the national mineral domain, but he had not yet become a distinctly professional man with a regular practice among private clients. That phase of geologic study did not ensue until the beneficial consequences of official examinations and reports became manifest in the actual search for ore on the surface and underground. As soon as this fact was appreciated, the enterprising owner

*Editorial in the 'Mining and Scientific Press' of February 15, 1919.

of mines, whether an individual or a company, turned to the geologist as a regular consultant. Thus a new specialist was evolved. We publish an interview with an honored representative of this branch of the mining profession, for he belongs more to the practical side than to the scientific, or, rather, he is a successful compound, having learned that the object of mining is to make money and not to prove or disprove hypotheses, while yet retaining a genuine love for scientific research. We are glad to publish the interview with Mr. Horace V. Winchell because he is a distinctly American product, both as an individual and as an example of the type of geologist that has done so much for the systematic exploration of our mineral resources. He comes of a family of geologists and illustrates the technical evolution to which we have referred, both his father and uncle having been professors of geology and State geologists, so that in his family we see the progression from the academic to the official geologist, and from the scientist to the practioneer. He was lucky in being born in an atmosphere so favorable to the incubation of the talent for which a demand was developing in the mining world. As a boy he showed a thirst for exact, as distinguished from vague, information. He determined early to become not an academic geologist but a practitioner, and he told his chum, Mr. John A. Blair, of this ambition. In 1887, when only 22 years old, while assistant State Geologist of Minnesota, he told Mr. Blair that he had ascertained the existence of an enormous iron deposit on the Mesabi range. As he says, it was "the practical side of geology" that attracted him from the start, when he was fortunate in serving his apprenticeship with two such capable field-geologists as the brothers N. H. and Alexander Winchell. Almost at the beginning of his career Mr. Winchell scored both a scientific and an economic success. He suggested the now accepted explanation for the origin of the Lake Superior iron ores and he predicted the future tremendous importance of the Mesabi range as a source of iron ore. In the treatment he received from the U. S. Geological Survey he was by no means unique; unfortunately the reputation of the Survey for generosity in giving credit to the mining engineers and unofficial geologists who have done pioneer work is in accord with the Mesabi story. We are in entire sympathy with Mr. Winchell the criticism that he implies. Besides his auspicious start

as a mining geologist, Mr. Winchell was fortunate in acquiring early in life an ability to write on his subject. To the articles that he wrote for sundry technical periodicals and transactions he owes his capacity for clear exposition, a capacity that he was enabled to put to profitable and honorable use when serving as an expert witness in mining litigation, a branch of mining geology in which he has earned a reputation second to none. His success in this work was due mainly to his thorough preparation as a geologist, in his grasp of the points involved, and in his direct application of scientific theory. The splendid library that he established in his office at Butte, as a part of the organization of a geological department for the Amalgamated Copper Company, enabled him to acquire an unrivaled command of information. At the same time he developed a system of underground maps, useful not only for litigation but for ore-finding, which it must be insisted, is the primary purpose of mining geology. He succeeded in that as he did in the courts of law. His name is linked with the discovery of the genetic principle we call secondary enrichment. Here again the geologists of the Survey took to themselves the lion's share of credit, mainly because Mr. Winchell's lips were sealed by the exigencies of a fierce litigation at Butte, so that he could not burst into print at the time when the gentlemen at Washington were thrilling the mining profession with their inductions and deductions. In later years Mr. Winchell came before the public as a protestant against the cancellation of the Cunningham coal-claims in Alaska, an enterprise in which he personally was interested and the killing of which, by an arbitrary act of the Government, aroused his bitter resentment. He made a plucky fight, in which he took with him the sympathy of many. The incident served to accentuate his dislike of the mining law and the administration of it. He led a powerful propaganda for the amendment of the regulations controlling the exploitation of the public domain and he consistently attacked the manifest defects of the so-called apex law. In these and other matters he has proved himself a fearless leader of men and a citizen of unquestioned public spirit. In him the mining profession, usually so inarticulate, has found an effective spokesman. It is not surprising therefore that he has recently been elected the president of the American Insti-

tute of Mining Engineers, an honor that he has earned and a position for which he is well fitted. The present writer has found himself in disagreement with Mr. Winchell more than once, as is likely between men so ready to express positive opinions, but we recognize not only the possibility of his being right and of our being wrong, but, what is more important, the sincerity of his purpose and the highmindedness of his motives. In the interview he outlines what he deems to be the main function of the Institute, namely, service to the profession. We feel sure that during his term of office he will further that concept and do something noteworthy in enabling the profession to play its proper part in the era of reconstruction bequeathed by the War. As for the more personal aspects of Mr. Winchell's character, we know several kind stories, of which the most memorable is that of a former partner, who testifies to his generosity in the early days of their practice at Minneapolis. The partner—it was Mr. F. F. Sharpless—did the assaying of iron ores while Mr. Winchell did the field-work. After the panic of 1893 the assay business went to pieces and prospects were black. Mr. Winchell made a sale of some iron-land, a deal entirely outside the partnership, and telegraphed to his discouraged associate that he was credited with a half-share of the commission. Blessed is the man with such a partner. Another friend tells us that he was a serious boy, whose chief enthusiasm was for music. Another likes to remember how this taste for music was manifested during the litigation at Butte when Mr. Winchell added to the jollity of the evening by singing 'Dunderberg's Sausage Machine', a song suggesting that his boyhood seriousness was not invincible. He has left a bright trail of good-fellowship and warm-heartedness wherever he has been, and that means much of the map; he has proved himself not only an untiring investigator and an exact thinker but a cheery companion and a loyal friend—in other words, a highly civilized man.

T. A. RICKARD

An Interview, by Charles Butters and W. J. Loring

B. You are of English origin?

Cornish on my father's side, Scottish-Irish on my mother's.

B. You were born in Cornwall?

No I was born in Pertusola, in Italy, in 1864. My father was in charge of a smelter operated by a British company at that place. Only last week we received a subscription to the 'M. & S. P.' from the Societa di Pertusola; in the accompanying letter the writer stated that he recalled my father's connection with the management and that since then the plant had grown so much that it was now the largest lead-smelting establishment in Italy.

B. So it seems that you happened, at your birth, to be connected with a sucessful enterprise.

Yes, I shall be glad to accept the coincidence as a mascot. I might add that thirty years ago, when in charge of mines in France, I had the pleasure of selling ore to the smelter at Pertusola.

L. Has that smelter been in operation continuously since that date?

Yes, it has. The control of it was acquired by Sir Thomas Brassey, later Lord Brassey, and it remained in the family until recently.

L. Your own family was connected with mining, then?

Yes, my father, Thomas Rickard, was the eldest of five brothers, all of whom were mining engineers and metallurgists. My grandfather was James Rickard, known as 'Captain' because he was a Cornish mine captain. He was one of the first accredited mining engineers to come to California, in the summer of 1850,

in behalf of John Taylor & Sons, a firm still honorably active in London, for whom he examined the Mariposa grant, then under option from General John C. Fremont, 'the Pathfinder' and the rival of Buchanan for the Presidency in 1856. My grandfather brought a sectional stamp-mill to California, to test the ore of the Mother Lode, and this was the first stamp-mill erected in California—at Coulterville, in Mariposa county. Hennen Jennings and Edward Benjamin told me that they had seen records to this effect, but unfortunately they were destroyed in the San Francisco fire.

B. The firm of John Taylor & Sons is the oldest mining engineering firm in existence?

Yes. I believe it is: and I am glad to say that, as the grandson of James Rickard, I am on friendly terms with the grandsons of the founders, John and Richard Taylor. I may add that my great-grandfather was Richard Rickard, also a Cornish mine captain, who was a man of distinction in his own little world in the 'old county', as the Cornish call it.

L. Were you educated in Italy?

No. Two years after my birth, my father went to Andeer, in Switzerland, for John Taylor & Sons, and after two years more he went to Russia as manager for the Russia Copper Co., operating two smelters and several groups of mines close to the Russo-Asiatic border. Some of the mines were across the border in western Siberia. My first recollection of mining operations is of an aerial rope-tramway in Switzerland, but my first memory of a mine is that of the copper mines at Kargalinsky, in the Ural region. In these, the copper occurred native and as carbonate—that is, in a form attractive to the eye, so that I remembered it. Moreover, the copper appeared as a replacement of plant remains in the Permian sandstone, and the peculiar character of these deposits naturally arrested my boyish observation.

L. What was your early education?

The first language that I learned to speak was German, because our nurse came with us from the German-speaking part of Switzerland, near Zurich. In Russia, my first teaching was received from a Russian tutor, and the first history I learned was

the history of Russia. Until I was fourteen, I thought in German, and spoke Russian better than English. While in the Ural, I used to accompany my father on some of his inspections, and I recall the fact more particularly that I acted as interpreter for him and for George W. Maynard, of New York. Maynard came there, I believe, to introduce some American concentrating machinery. Twenty-two years later, W. H. Emanuel, who represented Fraser & Chalmers in Denver, brought Maynard to my office, whereupon the following colloquy ensued. I asked him: "Are you Professor Maynard?" He admitted it. Then I said, "George W. Maynard?" He said "Yes". Whereupon I said, "I knew you long ago"; and he replied, "Are you that boy?" "I am". Our renewed acquaintance started a friendship that lasted as long as he lived.

B. To what school did you go?

While in Russia, my brother Forbes and I had a Russian tutor. Later, when I was eleven, the three oldest children, including my eldest sister, now Mrs. F. W. Baker, of London, traveled from the Siberian border to England, to go to boarding-schools. I remember that we went up the Volga, from Ufa to Nijni Novgorod, and then by train to St. Petersburg. The journey to England from the Ural took three weeks and three days. My brother and I went to school at Taunton, in Somersetshire. In England it would be described—pathetically—as a middle-class school, but it was a most excellent school. It is known now as Queen's College. We had a field club and a debating society. In the debating society we learned to speak while on our feet; in our field-club rambles we obtained glimpses of natural history. I remained there for six years and then matriculated at London University.

B. Was the teaching at this school helpful to you in your profession?

It was useful for mining engineering in so far as we received a smattering of science, but my taste at that time was all for English and the classics.

L. Had you already decided to follow in the footsteps of your father?

No; on the contrary, I had won a scholarship at Cambridge and was about to go there, with a view to adopting one of the so-called liberal professions, possibly the law, when I was diverted by the advice of my uncle, Reuben Rickard, who arrived in England on a visit from Berkeley, California. He was, as those that knew him will recall, a kindly and eminently sensible man. He urged me to follow the family calling, and I had so much respect for his sagacity that I did as he suggested.

B. *Don't you think you were particularly fortunate to have had the good sense at that age to be willing to accept the advice of an older man?*

I cannot analyze my reasons for accepting the advice, but I feel sure that one of them was the fact that I liked the adviser; so I went to the Royal School of Mines, in which at that time Huxley was dean of the faculty.

B. *You emphasize the fact that Huxley was the dean.*

Yes, indeed, because, although I was only a boy, I learned quickly to appreciate the fact that I was in touch with one of the great men of the world. He was an extremely attractive character in many ways. He would preside at some of our student meetings and always spoke so as to hold the attention and deep respect of the students. While at South Kensington, I had the honor of serving on a committee with him.

B. *How old were you then?*

I was eighteen or nineteen. The reason why I was chosen as a representative of the students on this committee was that, although I entered as a private student, I won a free studentship, so that I received monetary assistance from the Government, and that ranged me with the men who were being trained to be science teachers. Among them was H. G. Wells. After graduating, I bought a set of nine volumes of Huxley's essays for $10, and I have them still. What is more, I have lent them to several young men at different times during the last forty years.

L. *When did you graduate?*

I graduated with the class of 1885, in June of that year, and sailed by the 'Aurania' for the United States at once, before I had received my diploma, arriving at Denver on July 25.

B. To what extent has your college training helped you?

Greatly, of course. The teaching at the School of Mines was not as good, in some respects, as can be obtained now in many mining colleges in this country. It dealt more with principles and less with the application of those principles; it was more a college of science than a school of mines. Indeed, being the son of a mining engineer and having heard mining discussed at home so much, I skipped the mining course and took the one in metallurgy, because I had already made up my mind, from hearing my seniors talk, that practical mining was not a thing that could be taught in lectures. Having a scholarship and having a certain measure of choice in my curriculum, instead of going to the lectures that Sir Warington Smyth gave on mining in the afternoon, I went to Westminster and listened to the debates in the House of Commons, followed by afternoon tea where there was attractive company. The great benefit that I received at the Royal School of Mines was the stimulus imparted by mental contact with Huxley. He did not lecture to those of us who were graduating in mining or metallurgy, his subjects being paleontology and biology, but as I took a special course in dissection and biology in preparation for my B.Sc. degree in London University, I came under his spell. His lectures were windows to the infinite.

B. You said just now that the teaching was not so good in your time as in some of our modern schools, but is it not true that the purpose of the teaching in a college should be to impart a thorough knowledge of principles?

You are perfectly right, and I think some of our schools overlook this fact, giving too much time to details that are soon forgotten and soon obsolete, whereas the principles endure.

B. You also had more of your teachers' time than the average student obtains today in our crowded colleges.

That is true. There were twenty-four of us in our class, and only five or six graduated.

L. Who were your fellow students?

I have mentioned Wells. Sir Thomas Rose, the author of 'The Metallurgy of Gold', was in the class that followed mine;

in the class of '84 was Henry F. Collins, who was a brilliant student and won distinction. My own particular pals were Ernest R. Woakes, who is now with John Taylor & Sons, and Percy E. O. Carr, who was manager for the Mazapil Copper Co. and died at Saltillo during the Mexican revolution in 1918. My brother Forbes was in the class of '86. He is now living at Denver. My cousin James was my contemporary part of the time. Both of them graduated. Besides these kinsmen, my wife's brother, Harold Rickard, was also a student there, but several years later.

L. Were your college associations of any use to you in after life?

No they were not useful, although many of them were, and are still, delightful. The reason that they were not useful was that I left England and plunged into a new environment in the United States.

L. What did you first do after arriving at Denver?

I joined my uncle, Alfred Rickard, the youngest of my father's brothers, at Idaho Springs, in Colorado, as assayer to the Kohinoor & Donaldson Co. My uncle was manager for several British companies operating near Idaho Springs and Central City. I received my first pay, $100, on my twenty-first birthday. I had not taken the surveying course at the School of Mines, so late in the fall of '86 I went to Leadville as the guest of William Hanson, then the manager for the La Plata company, to which the firm of Rickard Bros. was consulting engineer. I stayed at the company's house and took advantage of the opportunity to learn surveying by working gratuitously with Charles Dunham, the company's surveyor. On going back to Central City, where my uncle was then living, I was appointed surveyor as well as assayer to a group of mines, and my pay was doubled, to $200 per month. I was glad to do the surveying, because, among other things, it enabled me to begin the study of structural geology.

B. Did you like surveying?

Not much. Our mine workings were small, extremely dirty, and cold. The surveying had to be done under conditions of

great physical discomfort; and although, of course, I was willing to face anything, I cannot say that I liked it.

B. Your pay was pretty good for that time.

Yes, but then you must remember that the manager was my uncle. What is the use of an uncle anyhow unless you can get good pay through him? Here I may add that Alfred Rickard was more like an elder brother than an uncle to me; he was a kind and considerate man, and a first-rate manager of mines, with a keen eye for exploratory work underground.

L. What did you do next?

After I had been with my uncle a couple of years, his wife died and he had to go to England with the children, leaving me in charge of several small mines. One of them was the California, which was the deepest gold mine in Colorado; the shaft was 2260 ft. on the dip of the vein, or 2040 ft. vertically. The hoisting was done with a hemp rope, and many is the time that I remember being startled when it would slip on the drum, giving the bucket a drop that made me fear it was going to the bottom.

During my uncle's absence, I received a visit from Philip Argall, who had succeeded Hanson as manager for the La Plata company, at Leadville. He had just returned from California, where he had been examining a gold mine. He seemed to like my work as temporary manager, and asked me whether I would like to be the manager of the mine in California. As I had been to California on a visit to my Uncle Reuben, at Berkeley, during the previous winter and had returned with a delightful impression of California, I told him promptly that I would be glad to go thither. The result was that I was appointed manager of a mine called the Union, previously owned by the Rathgeb brothers, four miles south of San Andreas, close to the road from San Andreas to Angels Camp, in Calaveras county.

L. You were rather a young mine manager, were you not?

Yes, I took charge soon after my twenty-third birthday. I had a house, hot and cold water, a Chinaman, a horse and buggy, and $300 per month.

B. I have noticed in your various writings a friendly feeling for Philip Argall, and now I can understand it.

Yes, sir; you are right. A fellow that cannot remember with gratitude the friend to whom he owed his first management of a mine would be a poor thing indeed. I had met Philip Argall when I was a boy of fourteen, when he was manager of the Duchy Peru mine, not far from Newquay, in Cornwall, as is recorded in my interview with him.

L. What was the result of your operations in Calaveras county?

The mine was a pocket mine. It was about 250 ft. deep when I took charge, but the quartz below the water-level, at 120 ft., looked hungry. At the time I became manager, about $275,000 had been spent on the purchase and equipment of the property, and only $7000 worth of gold had been won. In other words, it was a fizzle, for it had been sold on the report of the promoter himself, a man named Hamilton, who used to paint cuspidors and coal-scuttles for the Southern Pacific railway, and who got into mining in consequence of photographing mines and mining plants. The English company did the silly old thing of giving the management of the mine to the promoter, who thereby was able to cover up his chicanery, in the meantime receiving a handsome salary from his victims. Mr. Argall exposed the whole affair and advised a change of management, so I succeeded Hamilton. I did not know enough to hurt me, but I did see at once that the past production of the mine had come entirely from pockets above the water-level, so I put one or two trustworthy men to work in search of more pockets. This was successful. I took out $3000 in two hours with an iron candlestick myself, and a working miner took out $25,000 at a cost of $200, which was his pay, in one month. I paid him extra wages, because the work required a man of special integrity. I advised the company to do a little prospecting before they abandoned the enterprise. I remember that at that time I made the acquaintance of Charles D. Lane, who was running the Utica, and he told me that the show was no good because we were not in the 'black slate', of the Mariposa series. We were in gray schist, and our quartz was not of the ribbony kind characterizing the real Mother Lode mines. We were on the western edge of it.

L. Did you find much specimen ore?

No, only in spots. When I made a profit, thanks to these pockets, the directors wrote most complimentary letters, but when the returns dwindled, I received a letter upbraiding me for my failure; whereupon I wrote to them that, whereas I recognized that it was my duty to search diligently for ore and to extract it at the minimum cost, I declined to be held responsible for the distribution of the gold in the crust of the earth, because I had not been consulted by the Almighty when these interesting ore deposits were being created. The chairman of the company showed this letter to my father, a most punctilious gentleman, from whom I received a letter suggesting that I ought to be more respectful.

B. So at your first mine you received a fairly handsome salary and the poor shareholders received nothing? Were you ever in the happy position of being able to benefit both yourself and the shareholders?

Yes, I am glad to say that I have returned in dividends many hundred times more than I have received, for I have been manager or consulting engineer of mines that have yielded over $50,000,000 in gold and silver.

B. Do you think that you have received your fair proportion of the profits?

Yes, I think I have, for I did not risk my capital; as an engineer I did not receive much as compared with the promoters, but that is another story.

L. How long did you remain in Calaveras county?

Two years, from 1887 to 1889. Early in 1889 the directors sent a mining engineer to investigate conditions generally and incidentally to criticize my management. They took pains to select a man unacquainted with my family, an Australian named Charles Cowland. He proved to be a most agreeable man, for, among other things, he expressed a favorable opinion of my youthful attempts as a manager and asked me to go with him to Australia. So, in October 1889, I went with him to London and from there to Australia.

B. What did you do?

I examined several mines that he was promoting, and I re-

gret to say that I had to report unfavorably on most of them, but we continued to be friends. I had saved enough money from my salary in California to be able to travel, and this I did energetically. In the course of two years I examined eighty-five mines in Australia, all the way from Broken Hill to Mount Morgan.

B. Did you get fees for the examination of these properties?

No, sir; I received mighty few fees, and even those I found hard to collect, for in those days the people who paid for reports expected to see them first. However, I obtained a good working knowledge of the principal ore deposits of Australia and of the prevailing mining and metallurgical practices.

B. So you bought your experience?

Yes, in a measure. Here I may say that I began to write. I wrote several articles for the Melbourne 'Evening Standard'. My first contribution to the Transactions of the American Institute of Mining Engineers was my paper on Mount Morgan, which I wrote at this time and which was published in Volume 20 (1891).

L. Was this your first writing?

No, the first technical article that I wrote was on the Globe mill, a kind of ball-mill. This was when I was eighteen years old, and I remember being paid £6 for the job. My next article to appear in print was a description of the ore deposits at Redcliff, near Leadville; this I contributed to the London 'Mining Journal' in May 1886.

L. What led you to write?

The love of writing. While at school, I was editor of a manuscript magazine and contributed frequently to the printed magazine that was published quarterly. I may add that, as a schoolboy, I looked upon poetry as rather 'sissy' stuff, but one of our masters read us Tennyson's 'Lady Clara Vere de Vere' and the 'Ode to the Duke of Wellington', and I was so much impressed by both of them that I started to read Tennyson, and after that read four or five other poets right through. Shortly afterward I entered for the prize poem and was second, and the

next term I wrote the prize poem, the subject of which was the discovery of America by Columbus.

B. *So in your life's work you have followed your early bent?*

Yes, that is true.

B. *And thus obtained a double profit?*

To that I agree also, for if a man can do what he likes, if a man's hobby becomes his occupation, he is most fortunate.

B. *Turning back to your Australian experience, I remember your paper on the Bendigo saddle-reefs.*

Yes, that was one of my earliest contributions to economic geology. No doubt, for many years, if I was known at all, I was known as the author of that paper; and I would say for the benefit of the younger men that this was pleasant, because when I called on a mine manager or visited the office of a mining company and gave my name they would at once ask me if I was the man that had written about the Bendigo saddle-reefs. In other words, I made many mental acquaintances in consequence of that piece of writing.

B. *Which shows, Mr. Rickard, that the young man who early commences to write carefully about his work gets a benefit more far-reaching than he supposes.*

You are right. Apart from the enlargement of one's mental acquaintance, there is the benefit that comes to a man from having a reason for making notes and preserving his impressions of the things he sees. Anyone of us who visited a mining district ten years ago and is asked now to describe it will find extreme difficulty in giving anything but the vaguest description, whereas if we made notes at the time, and more particularly, if we took pains to prepare them for publication, we could now refresh our memories so as to give an intelligent account. The writing of a paper compels a man to crystallize his information on a subject; before that, it is amorphous.

R *It seems to me that our profession was fortunate in finding one among its number who was willing to retire from active work and write about what his fellow-engineers are doing, and I sincerely hope you may continue to fill that useful position. A friend of mine, Adolph Goertz, the head of the firm of Adolph Goertz & Co., who represented the Deutsche Bank in South Africa, said to me, "Butters, while it is important first to do a thing, it is equally as important, after doing it, to write about it, so that the world may know what you have done, because then the useful thing that you have done becomes common property". I think the average engineer is loath to write on what he is doing, and it is a pity. My first South African engagement was brought about by an article I wrote in 1889 to the 'Mining and Scientific Press' about a process for the treatment of low-grade tailings that I had developed at Kennett, in Shasta county.*

L. *What did you do after leaving Australia?*

I was examining a mine in Otago, New Zealand, when I received a cablegram from my father, asking me to come to France to take charge of a mine of which he was managing director. This was in 1891. In November of that year I went to Grenoble, in the Department of the Isère, and went from there to Allemont, where the French Mines, Ltd., was operating two groups of mines—a silver-lead group and a nickel-cobalt-silver group. The latter deposits, named Les Challanches, were a prototype of those at Cobalt, as was recognized and stated by Dr. Willet Miller in his official report as Provincial Geologist of Ontario in 1904, in which he quoted my description of the Challanches veins as given in Trans. A. I. M. E. of 1894. This old mining district in France is in a beautiful region, the Dauphiné; I lived in a house that belonged to the Dauphin, or son of the King, more than two centuries ago.

L. *Were the mines any good?*

No, of course not. The Lord rarely puts mines amid such lovely surroundings. My father was doing a lot of interesting engineering work, equipping the mines with single-bucket ropeways that ran up the cliffs, and erecting a concentrator at Grand

Clos. When the mill was about ready to start, we were checked by a severe frost. I did not regard this as a calamity, because I could see no future for the mines. The workings consisted of a series of galleries or adit-levels driven into a steep hillside. There was ore in the face of the top level and in the face of the bottom level, about 500 ft. apart vertically, and ore had been found in a vertical range exceeding this, but I could see no warrant for assuming that the ore in the lowest workings had persisted from an upper horizon on a level with the uppermost workings. On the contrary, I believed in measuring the persistence of the ore, not from the imaginary horizontal surface of a former geologic day but from a surface more nearly parallel to the inclined surface of the existing hillside. In the sequel this proved true, for the drifts ran out of ore at approximately the same distance from the surface.

L. So you did not stay there long?

No, I had lost confidence in the enterprise and was anxious to leave before the funeral.

B. In the words of Henry C. Perkins to Cecil Rhodes, in reference to Rhodesia, you did not want "to stay up with the corpse"?

Just about that time my Australian friend Cowland appeared on the scene again and made an appointment with me in Paris, where he asked me to join him as his assistant, he having been appointed consulting engineer to H. H. Warner, of Safe Cure fame. Warner was engaged in mining operations in the Western States, and Cowland recognized that he himself knew more about placer mining than he did about vein mining, so he wanted me to join him, and I was glad to do it, because the appointment took me back to Colorado and to my old haunts in the West.

B. What age were you then?

I was 28. I went to Denver and examined the old Caribou mine, in Boulder county, as well as other mines in other parts of the State. Later, on my advice, Warner bought the Hillside mine, near Prescott, Arizona, and then, to my horror, he started a share campaign characterized by practices of a questionable kind. The mine itself was a good one, but he capitalized it at

several times its value and then proceeded to gut it. I resigned, and opened an office on my own account at Denver. This was in 1893.

L. You were successful as a consulting engineer?

Yes, in a measure. In those days the opportunities for an independent engineer were better than they are now. In '94 I became manager of the Enterprise mine, at Rico, and in '96 I was appointed State Geologist by Governor McIntyre. I was re-appointed by the two succeeding governors, Alva Adams and Charles S. Thomas, so that I was State Geologist for three terms, or six years, until 1902.

L. When did you go to Australia the second time?

In 1897, while State Geologist of Colorado, I was engaged by the Venture Corporation to examine mines in Western Australia, which was then enjoying a boom.

L. Do you consider that the boom was justified?

Yes, it was, because some exceedingly rich ore deposits had been found at Kalgoorlie, not to mention those previously found near Coolgardie, but a great many wildcats had been foisted upon the public, particularly in London, on the strength of the real mines, and the people for whom I acted had acquired a good deal of property that was no good.

L. Whom did you meet in Australia?

Among others, Herbert Hoover. He had just come out for the firm of Bewick, Moreing & Co. As there were a number of pseudo-experts on the goldfields at that time, and mining engineering was rather in disrepute, it was a pleasure to meet a young man so keen and capable. He was then 23 years old and I was 33. As he came from California and I from Colorado, we naturally became pleasantly acquainted, and we agreed to exchange reports on wildcats; that is to say, we let each other know of prospects that we turned down, so as to avoid useless examinations.

L. How long did you remain in Australia that time?

I was there a year. Before returning, I examined some s at Bendigo for my clients and then returned by way of

London, reaching Denver in April 1898, just when the United States declared war against Spain.

B. Is there anything else that fixed that date in your memory?

You have made a good guess. It happens to be the date also when I declared peace with the lady who is now my wife—my cousin Marguerite, the daughter of Alfred Rickard, with whom I was first associated. I knew her as a child. My marriage is the cleverest thing I ever did.

B. I can corroborate that.

L. Did you resume practice at Denver?

Yes, and I established myself in nearly the same offices as before, in the McFee building. I was still under a retainer from the Venture Corporation, and examined one or two mines before I was able to recommend the Independence. This property was floated in London for a large amount of money and under circumstances that led to a fiasco, although the mine fully justified the report that I made on it in March 1899. In the same year I examined the Camp Bird mine and reported favorably upon it in terms that the history of the mine has confirmed.

L. Referring to the Independence fiasco, as you call it. I am aware of most of the facts and that the mine was placed in London at a price more than twice as great as your estimate of its value. You found yourself in a difficult position?

Yes. The dilemma was one that may present itself to a mining engineer at any time. It suggests the old question as to whether loyalty has any limitations. In other words, when is an engineer justified in turning on his clients? As to that, I will say that a man must play the game even after the other fellow has quit.

B. It was about this time, I believe, that you became an editor. What were the circumstances leading to this?

My work as consulting engineer compelled me to travel a great deal. For twelve years I averaged 35,000 miles per annum. During the first year after I was married, I was at home only once for a whole week, although I was at home several

times for a few days. I found the call to travel unpleasant because, naturally, I wanted to be more at home; and at that time I had begun to discover that, as I was called upon to examine big mines and continually bigger mines, I was compelled to take part in various ways in the negotiations incidental to the purchase of mines and to be associated with the promoters of mines, much of which work was entirely distasteful. It is a common experience in our profession that when an engineer achieves a certain position he is consulted by his clients not only as to the mines but also as to the negotiations, and he may have to take part in these negotiations and become cognizant of doings with which he is not in sympathy. These two considerations influenced me at the time when I received an opportunity to become an editor. After R. P. Rothwell died, the 'Engineering and Mining Journal' passed for a short time into the hands of W. J. Johnston, who had been running a paper called 'Mining and Metallurgy'. He had asked me to become editor of that paper and I had declined, telling him that he had better obtain control of the 'E. & M. J.', and if he did, I would consider an offer of the editorship. He did get hold of the 'E. & M. J.', in 1902 and promptly telegraphed to me, offering me the editorship. This part of the story has been told by me in the reminiscences that I published in the anniversary number of the 'M. & S. P.', on May 22, 1920. Toward the end of 1902, I went to New York to be ready to assume the editorship of the 'E. & M. J.', on January 1, 1903.

L. How long did you remain editor of the 'Journal'?

Until the first of July, 1905.

L. Why did you leave?

The paper changed hands over my head three times in the two and a half years. I had been able to work with the previous controlling owners, but found it uncongenial to work with John A. Hill, who was honest and capable, but rough and domineering.

L. Did you have a large interest in the 'E. & M. J.'?

The property was capitalized for $500,000; of this, $200,000

was in preferred stock held by eighty mining engineers. I myself held $50,000. During the Johnston regime I could have obtained control of the paper without difficulty, but I made up my mind that I did not want to have anything to do with the publishing end of the business. All I wanted to be was an independent editor, and therefore I did not second the idea of obtaining control of the paper for the profession, as would have been entirely feasible at the end of 1903.

L. Why were you adverse to this idea?

At the time of our troubles with Johnston, who was an erratic person, we had a finance committee consisting of three or four mining engineers of the first rank, including John Stanton and Ben B. Lawrence. I found out very soon that if the paper was to be controlled by a directorate of mining engineers it would be a coterie in New York—a coterie that, either individually or collectively, would expect to direct the policy of the paper, not for any wrong purpose, but still in a measure for their own interest or for that of their friends, entirely in what you might call a polite way. It seemed to me that this would endanger the status of the paper, and I felt sure that I would be uncomfortable under such an arrangement; so I used my command of the position with the idea of arranging that an experienced publisher should hold the common stock and exercise the business control, while I, as editor, would be left free to run the reading-pages.

L. What do you think of the Institute magazine?

B. Look out!

The Institute magazine is a feeble effort to do the very thing that I opposed—namely, the running of a periodical by a small group in New York without the discipline that comes from explicit responsibility. As both of you know, I feel strongly on this matter. The Institute magazine seems to me to be merely a subsidized form of journalism, and of 'kept' papers we have too many already.

B. I noticed on my last subscrption card to the Institute that $5 was set aside for the magazine, and I wondered if this $5 was spent on the magazine. If so, I felt that possibly a large number of the members of the Institute would like to spend their $5 elsewhere. I object to being obliged to pay $5 for something that I never read.

As I understand it, the $5 is allocated as a matter of form to comply with the postal regulations and is not supposed to measure the cost of the magazine. On the other hand, it does seem to me that a subscription price ought to be set on the magazine and that those who do not want it should not receive it. If a subscription price of $2 were put on the magazine it would be fair to those who do not want it; they would be relieved of paying for it. Meanwhile, the Institute would save a good deal of money in paper and postage—money that it needs very much at this time. Referring to the matter in a broader way, I venture to say that the profession owes just as much to the technical press as it does to the Institute; the time may come when it will be called upon to choose between a periodical published by the Institute, performing a function for which it was not intended, and a technical press that is established for the purpose of performing that function. It seems to me that the Institute is no more justified in engaging in these publishing activities than in running an ore-testing works or an assay-office at headquarters—in other words, the publication of a magazine is foreign to the purposes of the Institute, and it happens to be something that can be done better by those outside who have devoted themselves to that particular kind of work.

L. And who are independent?

Yes. If you want to see to what depth of depravity journalism can fall when it is subventioned and subsidized, you have only to go to London and see how such practices there have degraded the financial and mining journalism of that great centre. One bad custom is that of accepting payment for the publishing of the reports of company meetings, at varying rates per page, instead of treating them as advertisement. When I started the 'Mining Magazine' I printed such reports on the advertising pages at regular rates. This made it clear that the report of the

meeting was contributed by an interested party, not by our own reporter. I attended the meetings and commented on them editorially. Many of the financial journals levied a charge for publishing cablegrams and weekly reports from the mines, and even for recording the quotations on the shares of the companies. The system is honeycombed with graft.

P. You might explain why the companies are willing to pay for the publishing of the reports of their meetings.

The primary purpose is publicity; the printing of the proceedings helps to keep the company in the public eye and so assists the market for its shares; the secondary purpose is as a sop to Cerberus, to disarm the financial press. The purchase of space by the company for the report of its meeting, as for its prospectus when it is incubated, has the effect of silencing criticism and of eliciting compliment. The practice gives the promoter and company-monger a control of the papers that are venal, or even complaisant.

B. What about 'The Mining Congress Journal'?

There is some excuse for 'The Mining Congress Journal,' because the Mining Congress is, in essence, a political lobby at Washington in behalf of the mining industry, and it performs that duty admirably. Incidentally, it collects a good deal of information concerning the progress of legislation and it sends that information to many of its members, but not to all. If this information were sent in the same inexpensive form to all the members, the Congress would have done all the publishing that it is called upon to do, outside the annual volume containing the papers and addresses read and discussed at its conventions; but by publishing an elaborate monthly periodical on costly paper and by including a good deal of editorial comment, it also is competing unfairly with the technical press. It is wrong to regard the members, who have no choice in the matter of receiving the 'Congress Journal', as subscribers. Here again, if the Congress were to place a subscription price on its periodical it would find that the larger portion of its membership would not subscribe to the 'Journal'. The technical press is willing to compete with any paper that is issued on a legitimate basis, but it protests

against having to compete with papers that are subventioned by organizations specifically created for other purposes.

L. *Could the technical press give the publicity that the Congress requires?*

Yes, I think it could, and I believe that the two leading mining papers would be glad to co-operate for that purpose.

B. *You came to my laboratory in 1915 when I was conducting some preliminary experiments in flotation. At that time flotation was entirely a new subject to you. Since then I note you have published three books on the subject. How did you happen to take such a keen interest in flotation?*

In the first place, because I knew nothing about it and was curious to learn. My conversations with you showed me how interesting the process was and suggested to me that it was bound to prove of great importance to the mining industry. As at that time very few people knew anything about the process and as the few who knew something about it preserved a sphinx-like attitude, I decided that it would be useful and profitable to collect information and possibly even to make experiments with a view to giving the profession, through the 'Mining and Scientific Press', the information that was then of growing importance.

B. *I remarked to you jokingly at the time that you would be writing a book on the subject.*

Yes, I remember that you did, and I demurred smilingly, hardly believing at that time that I would have the temerity to write a book on the subject.

L. *When did you acquire control of the 'Mining and Scientific Press'?*

In 1905, but I did not assume the editorship until Jan. 1, 1906. I bought two-thirds of the stock of the Dewey Publishing Co., which is the holding company for the 'M. & S. P.', from J. F. Halloran and the remaining third from W. B. Ewer. My only reason for becoming a publisher was to be an independent editor.

L. *Did the 'M. & S. P.' prove a profitable venture?*

It has given an average return equivalent to that of the preferred stock of the average railroad or public utility corporation. During my absence in London the business dwindled sadly, and for three years we had no dividends.

L. You went to London to start 'The Mining Magazine'?

Yes, and I did this in response to the invitation of a number of British and American engineers in London. They felt the need of a good technical paper, so Edgar Rickard, who was business manager of the 'Press', and I went to London in June 1909 and started the 'Magazine' in the following September.

B. The 'Magazine' was a success, was it not?

Yes, it was a *succès d'êstime* and an interesting journalistic adventure, but the business it did was relatively small, because British manufacturers do not appreciate the value of advertising as much as ours do. However, the 'Magazine' became the most influential mining periodical under the British flag.

B. You have no financial interest in it now?

I sold my stock four years ago. Early in 1915, when the 'Press' was in a bad way, and actually losing money, I wanted my cousin, Edgar Rickard, to come here and look after it, while I continued to run the 'Magazine', but he had become associated with Hoover on the Belgian Relief Commission, so I left him with the 'Magazine' and came to San Francisco, in March 1915. I worked very hard to save the 'Press' and nearly lost my health in the effort, but within two years I had the satisfaction of seeing our subscription list more than doubled and our business on a profitable basis once more.

**A. You have done some non-technical writing?*

My book 'Through the Yukon and Alaska' is non-technical and the larger part of my 'Journeys of Observation' is also non-technical, but some of the chapters in the latter are severely technical and rather spoil the symmetry of the book. I have written many magazine articles that have not been technical, but most of them have dealt with some phase of mining. My field is distinctly that of class journalism; that is to say, I appeal to

*The questions marked 'A' and 'P' were interpolated by A. W. Allen and Arthur B. Parsons, the Associate Editors of the 'M. & S. P.'

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mainly because our people care less about being careful in this matter; but I can see signs of improvement.

A. In what way do you think that the maintenance of a high standard in technical journalism is helpful to the profession as a whole?

The technical press reflects the ideas and ideals of the profession. It has done a good deal to stimulate the development of character in the profession and to render the profession articulate in public. As literature is the criticism of life, so technical journalism is a criticism of the life of the technician. Obviously I cannot speak in terms of the present because I have been connected with the three leading mining papers of the world, but I can point to the good influence exerted by Rossiter W. Raymond and Richard P. Rothwell in their time. We who have succeeded them aim to carry on the work that they started.

A. You receive manuscripts from all parts of the English-speaking world. Do you notice the local influence of well-written technical journals?

Yes, only last week I received manuscripts from Yokohama, London, and Sydney. Your question is a sequel to the one that preceded it. The influence of a technical paper is a good deal more than local. Among other things, it brings together in thought men living at distances far apart, because they can use its pages for the discussion of interests common to all of them. It promotes peace and international good-will among technical men by establishing a mutual understanding of their work and purpose.

A. What is your opinion as to present-day activities in technical book publishing?

I marvel at the extent of the activities, and I wonder who buys some of the books that are published. As I review a good many technical books during the course of a year, I venture to note the urgent need for the services of a capable editor on the staff of each publisher. In most technical books will be found errors that should not escape the detection of a conscientious editor or even a capable proof-reader. The publishing of books

is conducted too much on a manufacturing basis, and too little as an art.

A. Do you think that some agreement might be made in regard to a uniform system of spelling in the English-speaking countries, as exemplified by the style adopted in the better-class publications?

Yes, I do. Indeed, there is a growing tendency toward uniformity. After all, the English language is the common heritage of all the English-speaking peoples, and a Britishism or an Americanism is equally objectionable, whether in spelling or locution. Moreover, as a book printed in English may be read in all the English-speaking countries, it becomes desirable from the publisher's point of view, in order to be pleasing, to adopt a spelling as nearly uniform as possible. For instance, in the 'M. S. & P.' we adopt the American way of spelling 'color', 'honor', 'labor', 'endeavor', and similar words; we also write traveling with one 'l', and use the 'z' in words signifying agency, such as 'standardize' and 'organize', but we use 'centre' instead of 'center', and we prefer to retain the French spelling of the metric units, believing that there is no gain in Anglicizing them, particularly as we use the word 'meter' in a sense different from 'metre'. For the so-called spelling reform, or simplifyde spellin, I have no use whatever.

A. You have interviewed a number of well-known men. What would you give as a definition of success, as applied to a mining engineer?

Success, of course, is measured at first in terms of dollars. The mining engineer that is paid a big salary and accumulates a large fortune is rated as a successful man. On the other hand, if in acquiring this fortune he has lost his health and, worse, has lost his friends, we come to recognize him as a failure. On the whole, I would say the mining engineer is successful that has done work of which he can be proud as a professional man, that has done work he knows to be useful, and that is able to retire not only with a handsome bank account, but in good health and in the possession of many friends.

A. Do you think that foreign travel and observation are essential to a proper appreciation of the technical and professional outlook of a mining engineer?

The mining engineer makes the whole world his field. Undoubtedly foreign travel and observation broaden a man's vision and widen his experience. Without travel a man is likely to be provincial. On the other hand, some people are parochial when they start on a journey around the world, and they end the journey without any enlargement of their mental horizon. Most of our leading mining engineers have been men that have traveled widely.

A. What pointers would you give to a would-be writer who wished to gain the sympathetic consideration of the editor of a technical publication?

In the first place he should have his article typewritten, because one of the first rules of writing is economy of attention on the part of the reader—that is, to save him as much trouble as possible. The typewritten text should be double-spaced, with an ample margin, so as to leave room for the editor's corrections. In the next place, he should take care to spell correctly the name of the person to whom his article is addressed, because an error in this particular is irritating to the recipient; when a man spells my name "Richard" or "Rickards" I resent it, because the blunder is a discourtesy, whether due to stupidity or carelessness. Next, he should accompany his article with a personal letter stating the circumstances that have prompted him to write it and describing the opportunities that he has had to obtain the information used in the article. If he is tactful, he will apologize for the possible errors in his writing and ask the editor's kind assistance in improving the text. I take pleasure in revising the manuscript sent to me by young fellows, although this work of revision is the most tiresome that I do. In many cases I send a clean copy of the edited text to the author, together with the original on which the corrections appear, and ask him to note the corrections, so that he may inform me if any of them have failed to convey his meaning. Usually I tell my correspondent that his manuscript has given me less trouble than most of those that come to me, and thereby save him from em-

barrassment. After one or two of his articles have been revised and amended in this way, sympathetically and helpfully, it is surprising how quickly an intelligent young man will improve in his writing. He learns to be careful instead of careless: he begins to appreciate the effect of using words properly.

P. What are your hobbies?

The technique of writing—on which I have published two books, as you know. If I am remembered when I am gone, it will be, I hope, as one who helped to improve the writing of those in the engineering profession. Another serious purpose in my life is to promote good-will between the English-speaking peoples, for I believe that in their friendly co-operation lies the one hope for the peace of the world.

P. You are an enthusiastic golfer?

Yes, I must accept the soft impeachment. My friends know that I play regularly. A few days ago a lady asked me if I played golf on Sunday, and I replied: "Yes madam, I take my golf religiously". I may add that I divide my week into two parts by playing on Wednesday also, sometimes morning and afternoon, usually afternoon only, working at home in the morning. After a round—or even two—of golf, I am in the right trim to do my writing. I believe in outdoor exercise as a means of clearing the brain and stimulating healthy thought. Before I became old enough for golf I played tennis with similar regularity.

P. What principal benefit do you think accrues to one who contributes an article to the technical press?

Apart from the gain in knowledge to the writer, caused by the need for compiling, correcting, and correlating his information on the subject of his article, the publication of it serves to give him publicity in an honorable way—in one of the few ways open to him honorably. The making of mental acquaintances by means of the printed word—an article in the technical press—is beneficial to all concerned. Most people are more ready to claim than to disclaim acquaintance with a member of their own profession: they feel that they have had contact with a man if they read something he has written, particularly if it be marked

by sincerity; so they are prepared to claim favorable knowledge of him whenever his name is mentioned. That is how reputations are made.

P. *Many young engineers would like to write for publication but are timid. Could you offer a word of advice to such men?*

I advise them not to write for publication too soon; they had better make notes on the technical operations in which they are engaged and put these notes together in the form of a lucid description, for their own use; thus they will acquire facility in writing; meanwhile they had better read Huxley and Stevenson, or Agnes Repplier and W. H. Hudson, and acquire a taste for good English; thus they will prepare themselves. Before long they will see something or do something on which they can write their first article, which they had better send to a sympathetic editor, willing to help as well as to criticize.

P. *What do you find to be the most prevalent fault in the manuscripts of inexperienced writers; in other words, what would you advise them to avoid?*

Carelessness and insincerity; the first is shown by blunders in grammar and composition, the other in attempts at so-called fine writing—purple patches—that are foreign to their style of expression. The two chief requisites in writing are to be careful in the use of words and sincere in the expression of thought.

P. *Do you find that many engineers take offense at criticism appearing in your editorial pages?*

No. Perhaps more are irritated than I suppose, for they are inarticulate. An editor worth his salt does not strive for popularity; he takes the risk of unpopularity. In any event, I am as willing to be judged by the enemies I have made as by the friends I have won. I have very few enemies—they may be inimical to me, but not I to them—I forget them. I regret if any of my criticisms give offense; the purpose of them is not to be offensive but to be useful, to be constructive, to create a healthy public opinion. That is the function of journalism.

AN APOLOGIA

By T. A. RICKARD

*During the last five years I have interviewed a number of members of the mining profession, thereby eliciting the salient facts in careers rich in human interest and full of useful suggestions to the younger men. Each interview has been accompanied by an editorial appreciation written by myself, for the purpose of rounding the story told in the interview and of pointng the moral of it—also perhaps for the sake of saying something that was both true and kind concerning men whom I liked. Twenty-three of these had been published when two of my 'victims' came to me with the suggestion that I ought to submit myself to similar cross-examination. This seemed to me neither unfair nor inappropriate: besides, it would give me an opportunity for saying a few things that could not be said in any other context. The interview appears in this issue. It was to have been published in the 'Mining and Scientific Press', but it may seem not inappropriate to the first issue of the 'Journal-Press', as a greeting to a new circle of readers. In lieu of the editorial appreciation that accompanied the other interviews, I have prepared an apologia—which is not an apology—wherein I comment upon the interview and explain some of the motives that have actuated me in my work as an editor.

I am proud of my Cornish ancestry and of my descent from the mine-captains of 'the delectable Duchy'. Our people, like many of the Cornish, are of Breton origin, for Brittany is much closer to Cornwall than most people realize, and many family names are common to St. Malo and Penzance. This sentimental tie with France pleases me, for I love France. *Chacun a deux patries, la sienne et la France.* The interview shows that as the son of a mining engineer I began to travel early and learned two foreign languages before I became fluent in my own. All this has tended to check provincialism or a narrow prejudice against the peoples of other countries. A cynic has said, "Patriotism is your conviction that your country is superior to all others because you were born in it". The cynic was G. B. Shaw, whom I dislike intensely and with whom I am glad to disagree. I was not born in the United States, and therefore my belief in its superi-

*From the 'Engineering and Mining Journal-Press' of April 1, 1922.

ority "to all others" is not based upon an accident; but it does coincide with my self-determination in the matter of citizenship. As a boy, in my visits to Cornwall, I used to look from the cliffs at Newquay across the Atlantic with the fixed intention of going to America, of which I had heard much from my father, who had been here many times on professional work. Besides, I met many Americans at our home, and I liked their cheery ways and expansive manner. As soon as I was graduated I came across. Besides my father, four of his brothers were in mining practice; fortunately I went to the youngest of the uncles, the one living in Colorado, for, apart from his attractive personality, the State of Colorado in the mid-eighties was an intensely interesting mining region, especially in its geologic aspect. My first visit to Leadville in 1886 was a great event. So was my first acquaintance with S. F. Emmons, whose later friendship I treasure among my happiest memories. Another man to whom I am indebted mentally is Mr. Richard Pearce, a Cornishman of the best type, a keen mineralogist and geologist, as well as a highly successful metallurgist. He used to welcome me to his house in Denver when I was in my twenties and would talk on vein structure and ore deposition. He is now living in England, and I am glad to send him this expression of my gratitude.

The interview tells the story of my travels. The two years in Australia and New Zealand—1889 to 1891—were rich in experience, especially of economic geology, which, in a measure, became my special study as a mining engineer. At that time the science of ore deposits was in an early stage of development, and one did not have to know much in order to know more than most people. Since then my friends Kemp, Spurr, and Lindgren, as well as Messrs. C. K. Leith and H. V. Winchell, have applied geology to mining in a manner and with a success few of us could have anticipated thirty years ago. Of my work as a mining engineer I can say that the geologic aspect of it was intensely interesting—that is, the finding of ore; also the appraisal and management of mines. But the contact with promoters and their wily ways I did not like, and before long I became disgusted with them, partly because they involved me in a fiasco that was the direct consequence of disregarding my advice. Of that I need say no more here except that it was one of the rea-

sons for my becoming an editor, a result for which I am grateful, for undoubtedly my life has been made happier, and possibly more useful, thereby.

A man is fortunate if he can find scope for his abilities, however moderate. The square peg in a round hole is the symbol of discomfort; the round peg snugly filling the round hole is the type of fitness. I have enjoyed the work that I have done now for twenty years. All normal men like power; some get it by means of muscle, others by the aid of wealth, others by the exercise of various arts. Of these, the art of writing makes its strongest appeal to educated men because it gives them power over their own kind; they become leaders of thought and moulders of public opinion, and that in a civilized community, especially one based on democratic ideals, is a splendid function.

As a mining engineer I wrote a great deal. My contributions to the Institute are equal in bulk to a volume of its 'Transactions'. I used to write frequently for the 'Engineering and Mining Journal' and occasionally for the 'Mining and Scientific Press'. Raymond and Rothwell, both identified with the 'Journal', were my honored friends, and I kept in close touch with them. My first experience as an editor in New York was rendered uncomfortable by the changes of proprietorship that followed the tangle into which Johnston involved the business affairs of the 'Journal', but I found that I liked the work. I formed the idea that an editor ought to control his paper in order to be independent. As a matter of fact, the successive controllers of the 'Journal' while I was editor did not interfere with the editorial policy, nor have they interfered with it since in the slightest, so far as I know; but I had just money enough to acquire control of the 'Mining and Scientific Press', and the lure of California was strong. If the earthquake had visited San Francisco a year earlier, I might have turned to Canada as a field for my journalistic activities; but I have no grudge against the earthquake. It was a stimulating experience, for it was great fun to carry the 'Press' through the period of stress and to reorganize our business successfully. 'The Mining Magazine' was an interesting adventure, for it gave me many new friends in the engineering profession and enlarged my knowledge of mining in its world-wide aspect. The 'Press' suffered by my absence in London, and for three years earned no profit. It was losing

money in 1915, when I returned to San Francisco and put my shoulder to the wheel in an effort to move it forward. For two years I worked so hard that I endangered my health and very nearly succumbed; but fortunately the stimulus given to the mining industry by the War came in the nick of time and carried the 'Press' forward to renewed prosperity. Nevertheless, I have been compelled to recognize the fact that the personal kind of journalism for which I have stood has the serious defect of being measured by the energies of an individual. Men think all mines will peter out except their own. Even Methuselah died. These are phrases that I have used in discussing the persistence of ore; they apply to the persistence of an editor. Indeed, I fear that the days of editor-publishers are gone. The business of publishing is becoming so big and so costly that the kind of man likely to be fitted for editor is unlikely to be the kind of man fitted to direct concurrently the workings of a big industrial establishment. It seemed wise therefore to accept the opportunity to consolidate the 'Press' with the 'Journal', especially when the consolidation was effected on honorable terms and under conditions that promise a wider field of activity not only for myself, but also for my two latest associates, whose skill and loyalty tempted me more than once to continue the 'Press' despite urgings to the contrary. It is a pleasure now to be associated with Mr. Spurr and to be connected with a paper that perpetuates the traditions of two papers of which I have been the editor.

The urge to write is the moving spirit of journalism and the impulse to criticize is the very life of editorial writing. Of patter and comment there is more than enough; the world needs criticism—the criticism of ideas, of methods, and of men. The true editor is driven by the demon of criticism, and I use the word 'demon' to mean not an evil prompter but an indwelling spirit. Sometimes his criticism hurts the feelings of the editor's friends, and he is sorry that it should, but that will not stay his hand, for if he once started to abstain from the performance of his self-imposed duty for fear of giving umbrage to one or two individuals, his usefulness would be at an end. Willingness to be unpopular and readiness to incur something much more unpleasant—the temporary estrangement from a friend—are the penalties of forceful journalism of the kind to which I am referring. An editor must learn to hold his friends "without cap-

itulation" of his convictions. Indeed, if a man's friends are engaged in the industrial and professional activities that are the subjects of his critical faculty as an editor, he is sure to annoy almost all of them sooner or later. That is the penalty of his position, and it is one that prevents many kindly spirits from becoming effective editors. One must have the courage of one's opinions to sit squarely in the editorial chair. I have tried to do so, and in doing it I have had to disagree with some of my friends, regretfully, but temporarily in most cases. I have accepted the penalty as part of the game—an honest and sportsman-like game when played properly. And it is one that must be played. The development of a wholesome public opinion is essential to the health of our democratic institutions. My own interest is mainly in that part of the public that is engaged in mining and its allied operations. Friends have suggested that I ought to be on a daily newspaper, just because I write occasionally on current non-technical topics. The suggestion finds no response, because by experience and by sympathy, I am an exponent of class journalism—of the journalism meant for a particular class, not the general public. In a mining paper I reach people with whom I have much in common, whom I understand, who are to me, as the Mexicans say, *muy simpatico*. In short although a journalist, I am still a mining engineer.